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# **JOURNAL OF SOUTH AFRICAN BOTANY**

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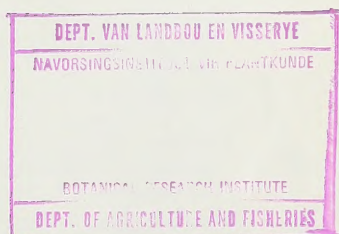
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# JOURNAL OF SOUTH AFRICAN BOTANY

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HIERDIE VOLUME WORD OPGEDRA AAN

PIETER GERHARDUS JORDAAN (1913— )

M.Sc., D.Sc. (Stell.)

(Professor in Plantkunde aan die Universiteit van Stellenbosch vanaf 1953–1978)

Hy was op die doserende personeel van die Departement Botanie, Universiteit van Stellenbosch, sedert 1940. Prof. Jordaan het hom beywer om die Departement Botanie uit te bou en beter fasiliteite vir navorsing daar te stel. Hy het veral navorsing gedoen op die voortplanting van die proteades, die ontwikkeling van plantgemeenskappe en die invloed van brand. Uit sy pen het die eerste publikasie in Afrikaans in hierdie tydskrif verskyn.

Hy was 'n stigterslid van die S.A.G.P. en ook lid van die eerste Raad, hy is 'n volle lid van die S.A. Akademie vir Wetenskap en Kuns en jarelank voorsitter van die Stellenbosse Tak van die Afdeling Biologie. Hy was vir meer as 25 jaar Hoof van die Botaniese Tuin van die Universiteit van Stellenbosch. Hy dien ook vanaf 1961 op die Raad van Trustees van die Nasionale Botaniese Tuine van Suid-Afrika, en vanaf 1967 is hy ondervoorsitter van hierdie Raad.



## THE INFLUENCE OF A FIRE IN APRIL ON THE REPRODUCTION OF THREE SPECIES OF THE PROTEACEAE

P.G. JORDAAN

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### ABSTRACT

The crown cover and density of three species of the Proteaceae were studied in plots on Paarl Mountain burned early in April 1961. The density of *Protea repens* and *P. burchellii* decreased markedly in all the plots studied while the density of *Leucadendron rubrum* decreased in some plots and increased in others.

The conclusion is that this autumn fire was unfavourable for the reproduction of the two *Protea* species.

### UITTREKSEL

#### DIE INVLOED VAN 'N HERFSBRAND OP DIE VOORTPLANTING VAN DRIE SPECIES VAN DIE PROTEACEAE

Die kroondekking en digtheid van drie spesies van die Proteaceae is bestudeer in persele op Paarlberg wat vroeg in April 1961 gebrand is. Die digtheid van *Protea repens* en *P. burchellii* het opvallend in al die persele afgeneem, terwyl die digtheid van *Leucadendron rubrum* in sommige persele afgeneem en in ander toegeneem het.

Die gevolgtrekking word gemaak dat hierdie herfsbrand ongunstig vir die voortplanting van die twee *Protea* spesies was.

### INTRODUCTION

In studying certain aspects of the reproduction of *Protea repens* (L.) L. (= *P. mellifera*), Jordaan (1949) concluded that January to March is a safe, April to June is an unfavourable and July to December is a dangerous period to burn this species in the veld. He also suggested that for other species of plants, which depends only on seed for reproduction, a safe and a dangerous period in a year to burn them can be expected.

The essence of the hypothesis put forward by Jordaan is that there are safe and dangerous periods during a year to burn species dependent on seed for regeneration. According to this hypothesis there must be, between these safe and dangerous periods, periods in which it is more or less safe/unsafe to burn them.

In studying the influence of a fire early in June 1960 on four species of the Proteaceae on the Paarl Mountain the following were the results (Jordaan, 1965): All plants and seeds of *Protea repens* and *P. burchellii* Stapf

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(=*P. pulchella*) were destroyed; plants of *Leucadendron rubrum* Burm. f. (= *L. plumosum*) were totally destroyed, but a few seeds remained to regenerate the species; all seeds of *L. salignum* Berg. (= *L. adscendens*) were destroyed but the plants sprouted from buds protected in or near the ground.

In 1972 Jordaan referred to the influence of fire at different times of the year on the reproduction of species of Proteaceae in a general discussion of the generative reproduction of the Proteaceae.

#### PROCEDURE

To control fires on the Paarl Mountain the Municipality of Paarl divided the mountain into six blocks (Map PW 854, dated August 1958, of the Municipality of Paarl). Block A was burnt early in April 1961 (therefore in the middle of autumn). I undertook to study the reaction of the Proteaceae to this autumn fire.

For purposes of study nine plots were delimited in Block A.

As in the case of the plot burned in June 1960 the vegetation in Block A was judged to be about 12 years old.

Although the area was well covered (crown cover about 80 %), the vegetation did not burn very well when it was put to fire early in April 1961. The results discussed here are based on observations made in April 1967—six years after the fire—in four plots that were well burnt. The areas surrounding these plots were also well burnt.

The crown cover of the species was estimated and their density was expressed as the number per 100 m<sup>2</sup>.

#### RESULTS

*Protea repens* and *Leucadendron rubrum* were present in all four plots studied. *P. burchellii* was present in only two of them. All three species were fairly evenly distributed in Block A.

All three species were produced only by seed.

The crown cover and the density of the species before and after the fire are set out in Table 1.

TABLE 1.  
Crown cover and density of species before and after an autumn fire

Species	Crown cover		Density	
	Before Burn	After Burn	Before Burn	After Burn
<i>Protea repens</i> . . . . .	8	+	63	7
<i>Protea burchellii</i> . . . . .	2	+	138	72
<i>Leucadendron rubrum</i> . . . . .	17	22	350	298



The crown cover and the number of plants of *P. repens* decreased markedly in all plots studied and it is concluded that the fire early in April was very unfavourable to the reproduction of this species. In the case of *P. burchellii* which was present in only two of the four plots studied, the crown cover and density decreased in both plots but not so markedly. The results indicate, however, that the fire early in April was unfavourable to the regeneration of *P. burchellii*.

The figures for *L. rubrum* give the impression that the crown cover and density was little affected by the fire. The results, however, differ in different plots. In one plot the crown cover and density decreased markedly (density from 750 to 250), but in three plots crown cover and density increased.

*L. rubrum* occurred in all nine plots in Block A. A similar variation in crown cover and density was found in the other five plots.

The results indicate that the fire early in April was not dangerous to the reproduction of *L. rubrum*. In three plots it was favourable and in one unfavourable.

#### DISCUSSION

As far as *Protea repens* is concerned the results are evidence that, as expected by Jordaan (1949), April is an unfavourable period to burn it. The results show that the fire in April was also unfavourable for the reproduction of *P. burchellii*. It was unfavourable in the sense that the density decreased. Both species, however, regenerated after the fire.

The reaction of *Leucadendron rubrum* differed from that of the two *Protea* species in that the effect was favourable in some plots and in others unfavourable. The reaction to the fire in winter (Jordaan, 1965) also differed from that of the two *Protea* species in that it was unfavourable for the regeneration by seed for *L. rubrum* and detrimental to the *Protea* species.

In assessing the influence of the fire in winter on *L. rubrum* the possibility of the dispersal of seed by wind into the area studied was taken into consideration (Jordaan, 1965). Wind might also have had an influence on the results of the fire in autumn on *L. rubrum*. The difference in the regeneration in the different plots might be due to the seed having been blown in and out of the plots. In the case of *P. repens* and *P. burchellii* the results were such that there is no reason for doubt that the fire in winter was detrimental to and the one in autumn unfavourable for the regeneration of the two *Protea* species.

Bond (1980) reports the influence of a fire in March (autumn) and in September (spring) in mature (20 years) and senescent (40–45 years) fynbos in the Swartberg. The fynbos contained, amongst others, *Protea repens* and *Leucadendron rubrum*. The Proteaceae regenerated well after the fire in March.

The different reactions of a species to fire in different months of the year is of great importance for the conservation of the species concerned and is a subject that needs further study. A priority is to get results of fires in different months of the year on individual species.

#### ACKNOWLEDGEMENT

I wish to thank the Municipality of the Paarl for burning the area studied as requested, the students and members of the staff of the Department of Botany of the University of Stellenbosch for their assistance in making the necessary observations and the Government Herbarium, Stellenbosch for the correct names of the species.

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## **SINEOPERCULUM VAN JAARVELD: 'N NUWE MONOTIPIESE GENUS IN DIE FAMILIE MESEMBRYANTHEMACEAE**

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### **UITTREKSEL**

'n Herwaardering van *Dorotheanthus rourkei* L.Bol. is nodig geag as gevolg van kenmerkende verskille in die kapsule sowel as die blom en die genus *Sineoperculum* word beskryf en verskille met naverwante word bespreek. 'n Volledige beskrywing van *Sineoperculum rourkei* word ook verskaf en die uitwendige blomontwikkeling word aangedui.

### **ABSTRACT**

#### **SINEOPERCULUM VAN JAARVELD: A NEW MONOTYPIC GENUS IN THE FAMILY MESEMBRYANTHEMACEAE**

A re-evaluation of *Dorotheanthus rourkei* L.Bol. was considered necessary as a result of distinctive differences in the fruiting capsule and flowers, and the genus *Sineoperculum* is described. Differences to related genera are also discussed and a complete description of *Sineoperculum rourkei* is given and the external flower development presented.

**Sineoperculum** E. J. van Jaarsveld, genus novum, *Dorotheantho* affine sed differt stigmatibus dimidio connatis, cellulis capsulae sine operculis, valvis sine alis, et placenta sine tuberculo.

*Tipe-spesie:* *Sineoperculum rourkei* (L.Bol.) van Jaarsveld.

Eenjarige vertakte kruid, opvallend gepapilleer. *Blomme* 5-delig, eindstandig, enkel, gloeiend helderrooi tot donkerrooi. *Kelkblare* 5, nabywend en uitdrogend tot 'n nabywende skelet as leeftyd van plant voltooi is. *Kroonblare* 2-seriaal, skerp puntig. Die skerp puntige kroonblare raak toegespits  $\pm 5$  dae na die oopgaan van die blom deurdat die kroonblaarrande vanaf die punt na die abaksiale kant inrol wat die naald-skerp voorkoms van die kroonblare veroorsaak. *Meeldrade* 2-seriaal. *Vrugbeginsel* 5-hokkig omgekeer keëlvormig, plasentasie pariëtaal. *Stempels* 5, vergroei vir  $\pm$  helfte van die lengte, nabywend aan die kapsule.

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Vir publikasie aanvaar 11 Augustus, 1981.

*Kapsule* hokverdelend, hokvlerke afwesig, hicrochasties, afgeplat omgekeer keëlvormig. *Kleppe* 5 met  $\pm 3$  gelykhoekige sye. Kielweefsel sonder klepvlerk, afgeplat en min of meer parallel met buitenste rand van hok. *Plasenta* wandstandig en sonder plasentale knoppe.

Verwant aan *Dorotheanthus* en *Micropterum* maar verskil deur die vyf stempels wat halfpad vergroei is, die kleppe wat sonder vlerk of angel is, en die hokvlerke wat afwesig is en die plasenta wat sonder knoppe is.

Die Latynse naam *Sineoperculum* is afgelei van sine = sonder, en operculum = deksel, en verwys na die kenmerkende vlerklose hokke.

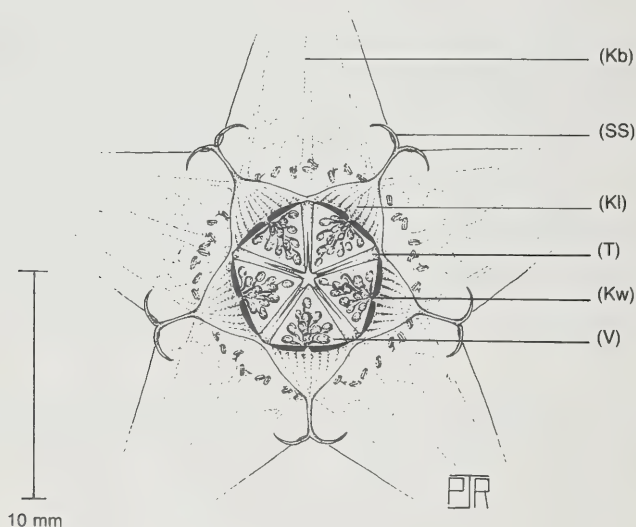


FIG. 1.  
'n Bo-aansig van die kapsule

- K = Kelk
- Kb = Kelkblaar
- Kl = Klep
- Kw = Kielweefsel
- SS = Stempel en styl
- T = Tussenskot
- V = Vrughok



# BESPREKING

In dr. Louisa Bolus se Latynse beskrywing in die *Journal of South African Botany* 35(3): 143–144 (1969) word geen melding gemaak van die morfologie van die kapsule nie, wat die belangrikste skakel in die klassifikasie van die familie Mesembryanthemaceae is. Dit is eienaardig dat sy ook nie melding gemaak het van die stempels wat vergroei is of die kroonblare wat kenmerkend „verskerp” by groeitoename nie. Dr. Rourke het aan my genoem dat dr. Bolus onseker was oor die morfologie van die kapsule en sy was ook nie seker of sy die plant in die genus *Dorotheanthus* moes plaas nie. Eienaardig genoeg, het sy die saak nooit verder gevoer of daarvan melding gemaak in haar beskrywing nie. Die morfologie van die kapsule van *Sineoperculum*, nl. hokke sonder hokvlerke, die kleppe wat sonder vlerk of angel is, sowel as die vergroeide style, maak dit ’n onderskeibare monotipiese genus.

TABEL 1.

’n Vergelyking van die kenmerke van *Sineoperculum* en naverwante genera.

	<i>Sineoperculum</i>	<i>Dorotheanthus</i>	<i>Micropterum</i>
Stigma . . . . .	Stempels halfpad vergroei	Geen vergroeiing	Geen vergroeiing
Kapsule . . . . .	a. Hokvlerke afwesig b. Kielweefsel sonder vlerk of angel c. Plasenta sonder knoppe	Goed ontwikkelde Hokvlerke Kielweefsel met vlerk en angel Plasenta met knoppe	Hokvlerke half ontwikkel Kielweefsel met vlerk sonder angel Plasenta sonder knoppe

As gevolg van die kort onvolledige Latynse beskrywing van die spesies in die *Journal of South African Botany* (1969) word ’n volledige beskrywing van die plant geplaas. Dit is gedoen van lewende plante wat gekweek is van saad afkomstig van Rietputs, asook van gedroogde herbarium-eksemplare.

***Sineoperculum rourkei* (L.Bol.) van Jaarsveld, comb. nov.**

*Dorotheanthus rourkei* L.Bol. in *Journal of S. Afr. Botany* 35(3): 143 (1969)—basionym. Jacobsen, *Lex. of Succ. Pl.*: 464 (Blandford, 1974).  
 Typus:—3017 (Hondeklipbaai): omtrent 15 myl suid van Garies (-DD), 8 Aug. 1967, J. P. Rourke 814 (BOL, NBG).

Vertakte sagte eenjarige sukkulente kruid tot 70 mm hoog en 140 mm in deursnee, gepapilleer. *Stingels* kort, platgroeënd tot neerliggend bruinrooi getint. *Blare* teenoorstandig, aanvanklik rosetvormig, verenig by basis of vry, blaarsteelagtig by basis, spatelvormig, of smal omgekeer lansetvormig

of lineêr, tot 80 mm lank en tot 16 mm breed, opvallend gepapilleer aan abaksiale blaarvlak met skerp puntige of stomppuntige, deurskynende, half-rond tot langwerpige papillae tot 1,5 mm lank met punte gerig na blaarbasis. *Blomme* 5-delig, terminaal, enkel, gloeiend helderrooi tot donkerrooi,  $\pm 45$  mm in deursnee (uitsonderlik tot 60 mm) aan skutblaarlose stele tot 70 mm lank. *Blombodem* omgekeer keëlvormig, aanvanklik 4 mm hoog en 5 mm breed en wat vergroot by groeitoename; opvallend gepapilleer. *Kelkblare* 5, blaaragtig, bruinrooi getint, vernou, stomp of skerp puntig, die buitenste paar teenoorstaande en langer; 3 binneste kelkblare korter met membraanagtige rande; tot 10 mm lank en 3–4 mm breed by basis en vergroot tot 15 mm lank en 8 mm breed by groeitoename, nabywend en uitdrogend to 'n skelet as leeftyd van plant voltooi is. *Kroonblare* 2-seriaal, smal-lansetvormig, skerp puntig, tot 4 mm breed; binneserie  $\pm 15$  mm lank wanneer blom oopgaan en verleng tot  $\pm 21$  mm na 5 dae met groeitoename; buiteserie 21 mm as blom oopgaan en verleng tot 27 mm na  $\pm 5$  dae met groeitoename. Die skerp puntige kroonblare raak toegespits na  $\pm 5$  dae deurdat die kroonblaarrande vanaf die punt na die abaksiale kant inrol wat die naald-skerp voorkoms van die kroonblare veroorsaak. *Meeldrade* 2-seriaal,  $\pm 3$  mm lank, oranje; *helmknoppe* geel. *Vrugbeginsel* omgekeer keëlvormig, 5-hokkig; plasentasie pariëtaal. *Stempels* 5, ryp na  $\pm 5$  dae, elsvormig, gepapilleer aan binnevlak, 4,5 mm lank, vergroei aan basis vir  $\pm$  helfte van die lengte ( $\pm 2$ –3 mm), nabywend aan vrug. *Kapsule* hicrochasties, hokverdelend, hokvlerke afwesig, afgeplat omgekeer keëlvormig 4,5 mm hoog en 8 mm breed met 'n sentrale as; *kleppe* 5, elk met 3 gelykhoekige sye respektiewelik 4 mm lank, sonder vlerk of angel, kielweefsel afgeplat en min of meer parallel met buitenste rand van hok. *Plasenta* wandstandig en sonder knoppe. *Saad* veelhoekig, glad, 14–24 sade per hok ( $\pm 70$ –120 sade per kapsule), tot 18 kapsules per plant in 'n leeftyd. Leeftyd van plante is ongeveer 5 maande.

#### HABITAT

Die plante kom verspreid voor in die Sukkulentekaroo (Acocks Veld-tipe Nr. 31) in 'n baie droë, rooi, sanderige goedgedreineerde, plat tot heuwelagtige kusvlakte wat granities van oorsprong is. Die plantegroei is xerofties en word gedomineer deur die familie Mesembryanthemaceae. Reënval is hoofsaaklik in die winter en wissel van  $\pm 100$ –200 mm (April–September). Ekstra neerslag word ook ondervind as gevolg van die mis wat somtyds van die Atlantiese Oseaan inbeweeg en op vaste stowwe kondenseer. Die plante by Rietputs is versamel in assosiasie met *Micropterum papillosum*, 'n naverwante eenjarige vygiëtië. Die winters is matig en ryp is onbekend. Temperature kan soms skerp styg op still, windlose nie betrokke

dae in die somer asook somtyds in die winter wanneer bergwindtoestande heers.

#### VERSPREIDING

Kom voor in Namakwaland se sanderige kusvlakte en is tot dusver slegs bekend van Wallekraal in die noorde tot Nuwerus in die suide. Die noordelike verspreidingsrekord, alhoewel nie gestaaf deur 'n herbarium-eksemplaar nie, kom by Fay Anderson wat die plant in September 1956 by Wallekraal afgeneem het. Dit is die vroegste rekord bekend.

#### EKSEMPLARE ONDERSOEK

KAAPLAND—3017 (Hondekliipbaai): Omtrent 15 myl suid van Garies (-DD), 8 Aug, 1967, *J. P. Rourke* 814 (BOL, NBG).

—3118 (Vanrhynsdorp) : Rietputs (-AB), 11 Sept. 1979, *H. Hall* 439.

Die morfologie van die kapsule van *S. rourkei* is interessant. Die afwesigheid van hokvlerke en die plasenta sonder knoppe verseker die vinnige vrystelling van saad in 'n reënbui. Die saad bevat egter 'n inhiberingsfaktor wat verhoed dat al die saad op een slag ontkiem; dit is 'n oorlewingsfaktor. In kontras hiermee is die morfologie van die kapsule by *Dorotheanthus* en ander meer gespesialiseerde genera soos *Cephalophyllum* en *Namaquanthus* van so 'n aard dat slegs enkele sade in 'n reënbui vrygestel word. In hierdie geval ontkiem die saad weer maklik sonder enige noemenswaardige inhiberingsfaktor. Hierdie gegewens is eksperimenteel vasgestel onder gekontroleerde glashuistoestande.

Nog 'n interessante eienskap van die kapsule by *S. rourkei* is die kelkblare wat nabywend is en vergroot en dan verdroog tot 'n nabywende skelet. Sou dit miskien 'n ontwikkeling wees wat gebaseer is op oorlewing? Die habitat van *S. rourkei* is af en toe, veral in die wintermaande, onderhewig aan mis vanuit die see. Dit is moontlik dat die vogtige mis op die kelkblare kondenseer en dan sodoende ekstra vog aan die ontkiemende saad asook aan jong plante in die omgewing van die moederplant verskaf.

#### KWEEKPOGINGS EN EKSPERIMENTE

Ontkieming van die saad was tot dusver slegs gedeeltelik suksesvol. 'n Baie klein persentasie van die saad wat te Rietputs deur my en Bruce Bayer versamel was, het wel ontkiem. Die saad is gesaai onder gekontroleerde glashuistoestande in Kirstenbosch, op 29/3/77 in 'n sanderige, goedgedreineerde leemgrond en slegs 31 saailinge is voortgebring. Ontkieming het sporadies plaasgevind van 13/4/77 tot Mei 1977. Die saailinge is oorgeplant in asbestoshouers op 12/5/77 in 'n soortgelyke medium. As gevolg van die hoë minerale inhoud van die grond van sy natuurlike habitat, is die saailinge

gereeld bemes met 'n vloeibare kunsmis. Die eerste blomme het op 20/8/77 verskyn en die plante het aangehou met blom tot einde September en begin Oktober. Eksperimente is gedoen op 22 verskillende blomme van verskillende plante en die doel daarvan was om die algemene uitwendige ontwikkeling van die blomme te ondersoek. die metode is as volg aangewend: Twee-en-twintig blomme van verskillende plante is geëtiketteer en die volgende informasie en resultate is onttrek:

1. Gemiddelde blomleef tyd:  $\pm 9$  dae.
2. Die lengte van die kroonblare by blomopening is:
  - (a) binne-serie gemiddeld 17 mm wat tot 21 mm verleng;
  - (b) buite-serie gemiddeld 21 mm wat tot 27 mm verleng.
3. Tydperk wat stempels neem om ryp te word ná die blomopening—3 tot 4 dae.
4. Tydperk vanaf blomopening totdat die kroonblare “verskerp”  $\pm 5$  dae.

#### BEDANKINGS

Die volgende persone word bedank:

John Rourke vir die vertaling van die genusbeskrywing in Latyn; Koos Roux vir die illustrasie; Johan Grobler vir raad; Mej Bosman vir die nasien van die manuskrip.

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## NOTES ON ORCHIDS FROM SOUTH CENTRAL AFRICA

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### ABSTRACT

A new variety of *Habenaria* is described. *Tridactyle teretifolia* Schltr. is considered to be synonymous with *T. tridentata* (Harv.) Schltr. and *T. filifolia* (Schltr.) Schltr. is reinstated as a species separate from *T. tridentata* (Harv.) Schltr..

### UITTREKSEL

#### NOTAS OOR ORGIDIEË VANAF SUID-SENTRAAL AFRIKA

'n Nuwe *Habenaria* variëteit word beskryf. *Tridactyle teretifolia* Schltr. word beskou as 'n sinoniem vir *T. tridentata* (Harv.) Schltr. en *T. filifolia* (Schltr.) Schltr. word heringestel as 'n soort afsonderlik van *T. tridentata* (Harv.) Schltr.

***Habenaria* (sect. *Multipartitae*) *praestans* Rendle in J.B. 33: 293 (1895).**

var. ***umbrosa*** Williamson, var. nov. a varietate typica caule gracili, inflorescentia laxa, floribus paucis, labello lateralibus lobis filamentis paucis, crescens in umbrosi sylvis humidis differt.

*Typus*: Zambia, Lusaka, *G. Williamson 1867* (holotypus, SRGH) (Fig. 1).

**ZAMBIA**: Central Province: Refunsa, Feb. 1964, *Morze 160* (K); 5 km south of Serenje in perennial wet floor of relict rain forest, Feb. 1968, *Williamson 761* (SRGH); 7 km west of Lusaka in *Syzygium* forest, Feb. 1969, *Williamson 1381* (SRGH); 6 km west of Lusaka on wet forest floor, Feb. 1970, *Williamson 1867* (SRGH, holo.); same locality one week later in adjacent forest, *Williamson and Drummond 1868* (SRGH); same locality, Feb. 1971, *Williamson 2051* (SRGH); 4 km south of Serenje in swamp forest, Feb. 1971, *Williamson 2053* (SRGH); near Serenje in swamp forest, Feb. 1972, *Williamson 2215* (SRGH).

**MALAWI**: Northern Region: Base of Mafinga Mtns., near Chisenga Rest House in wet gallery forest beside stream, Feb. 1970, *Williamson and Drummond 1946* (SRGH).

This new variety of *H. praestans* Rendle (Fig. 1) unlike the typical variety (Fig. 2) varies very little over its range. It only occurs on the floor of dark wet relict forest whereas the typical variety is a plant of open upland and montane grasslands. The new variety has a relatively lax inflorescence with

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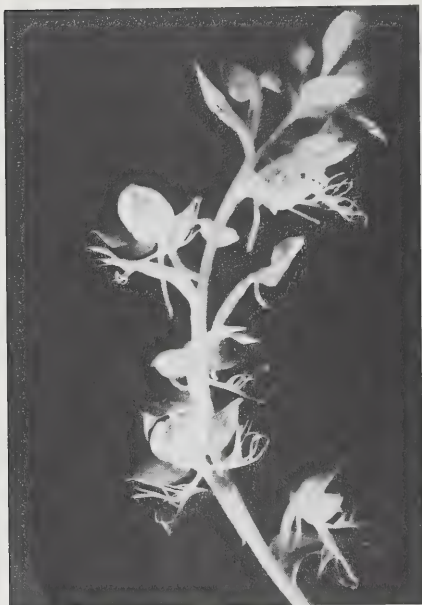


FIG. 1.

*Habenaria praestans* var. *umbrosa*,  $\times 1/2$ . Photo of a plant collected in swamp forest, Baluba headwaters, north of Ndola, Copperbelt, Zambia.

fewer flowers. The flower bracts are more prominent and leaf-like and always longer than the flowers. The flowers are generally smaller in all dimensions with the lateral lobes of the labellum held at right angles to the middle lobe. The lateral lobe filaments are always fewer. The spur is much shorter than the labellum midlobe. In the new variety the staminodes are not always stalked as they are in typical *H. praestans*. In *H. praestans* var. *umbrosa* the flowers are also more luminescent especially the white of the petals, labellum and anther-connective which might be in keeping with a plant adapted to dark, dank forest conditions.

***Tridactyle tridentata*** (Harv.) Schltr, in Engl. Bot. Jahrb. **53**: 603 (1915); Summerh. in K.B. **1948**: 287 (1948); Harrison in Epiph. Orc. S. Afr.: 83 (1972). Type: Repub. of S. Africa, Natal in Kranskloof on jutting rocks, alt. 300 m, fl. Dec. Jan. 1862, *J. Sanderson* 562 (TCD, holo.) Figures 3 and 4.

*Angraecum tridentatum* Harv. in Thes. Cap. **2**: 6 (1863); Rolfe in F-C. **5.3**: (1912).

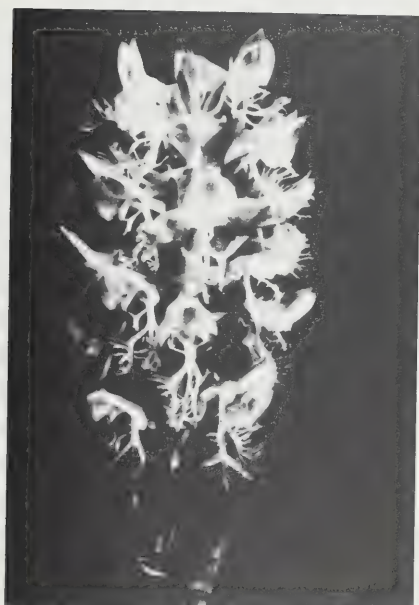


FIG. 2.

*Habenaria praestans* var. *praestans*,  $\times \frac{1}{3}$ . Photo of a plant collected in open montane grassland, Nyika Plateau, Zambia.

*A. bolusii* Rolfe in F.C. 5.3:73 (1913). Type: Zululand, near Eshowe, Maxwell Herb. Bolus No. 6319 (BOL, holo.!).

*Tridactyle teretifolia* Schltr. in Swd. Rhod. Kongo Exped. (1911-12): 251 (1916), syn. nov. Type: Zambia (North Eastern Rhodesia), North. Prov., Mbala (Abercorn), Nov. 1911, R. E. Fries 1273 (UPS, holo.) Fig. 4,N.

*T. bolusii* (Rolfe) Schltr. in Engl. Bot. Jahrb. 53: 603 (1915) (in obs.).

*Angraecum hislopii* Rolfe in K.B. 1920: 130 (1920). Type: A. Hislop 67 (K, holo.!).

#### MATERIAL EXAMINED

ZAÏRE: Shaba (Katanga), Lubumbashi (Elizabethville) very common on trees, Nov. 1923, C. W. V. Hirschberg 6 (K); Kundelungu Plateau, Shaba, *Malaisse* 4835 (K). TANZANIA: Musoma Distr., 1 mile from Mara Riv., growing on *Parinari* in open woodland, P. J. Greenway 10244 (K). MALAWI: Scarp road from Blantyre to Chiwawa, epiphyte on tall trees, Dec. 1974, D. Westwood 701 (SRGH). MOZAMBIQUE: Vila de Manica, frequent on scattered trees, Dec. 1956, E. Harrison 70 (BOL).

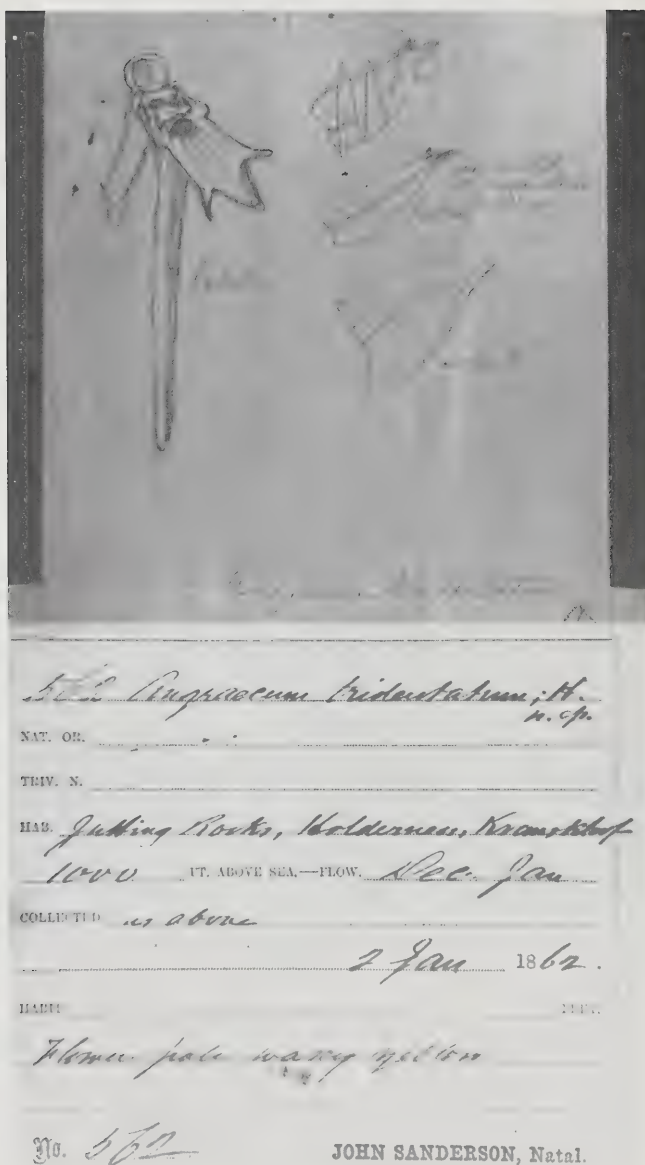


FIG. 3.

Drawing by Harvey from the type sheet of *Tridactyle tridentata* in TCD. Photo by kind permission of Professor D. A. Webb, Trinity College, Dublin.

ZAMBIA: West. Prov.: Solwezi, common epiphyte in dry bush, Nov. 1958, *W. D. Holmes* 023 (SRGH); Mwinilunga Distr., Matonchi, Nov. 1969, *Williamson and Drummond* 1739 (SRGH); Mwinilunga, live plants, March 1969, *Williamson* 1603 (K); Barotse Prov.: 10 km east of Mongu, Nov. 1959, *Drummond and Cookson* 6355 (SRGH); North Prov.: Mbala (Abercorn), Nov. 1861, *W. Moroney* 253 (SRGH); Cent. Prov.: Lusaka, *J. H. Morze* 28 (SRGH); Kapiri Mposhi, Sept. 1967, *G. Williamson and B. Simon* 588 (SRGH); Kanono Hill, on rocks: sheet 1.5 km south of Serenje on *Brachystegia* trees: sheet 2, Sept. 1968, *Williamson* 1127 (SRGH); same locality, live plants, Feb. 1969, *Williamson* 1502 (K).

ZIMBABWE: Salisbury Distr., Dombashawa, growing on masasa trees, Nov. 1947, *H. Wild* 2252 (SRGH); Chimanimani, Oct. 1954, *J. S. Ball* 394 (SRGH); Gutu Distr., 1967, *D. Mackintosh* 4 (SRGH); Charleswood on road to Chimanimani Nat. Park, Nov. 1973, *J. S. Ball* 1371 (SRGH); Mevumodzi River, March 1974, *A. J. Beasley* 218 (SRGH); Salisbury Distr., Great Dyke Pass on road to Banket, on trees on hillside, *J. Renz, R. Grosvenor and R. B. Drummond* 11335 (SRGH).

REPUBLIC OF SOUTH AFRICA, NATAL: Eshowe, Zululand, Dec. 1936, *J. Gerstner* 1865 (BOL); near Eshowe, Zululand, Dec. 1893, *Maxwell* 6319 (BOL); Port Edward, Dec. 1977, *J. Stewart G. H. S.* 261236 (SRGH).

Summerhayes in *African Orchids* 18 in K.B. 1948: 287 (1948) placed all the West African rain forest fine terete leaved *Tridactyles* in synonymy with the South African savanna terete species *T. tridentata*. At this stage he maintained *T. teretifolia* as a distinct species.

From an extensive examination of live and herbarium material plus a comparison of the drawing of the type of *T. tridentata* by Harvey on the type sheet at Trinity College, Dublin (Fig. 3) and a recent drawing of *T. teretifolia* by Mr Lars Jonsson from the type preserved in spirit in Uppsala, (Fig. 4, N), it is evident that *T. teretifolia* must be placed in synonymy with *T. tridentata*.

The taxon known as *T. bolusii* (Rolfe) Schltr., although displaying very fine leaves with average 2 mm across and somewhat smaller flowers than the type of *T. tridentata* nevertheless falls well within the range of *T. tridentata*. The labellum of *T. bolusii* on the type sheet is 3 mm long and has rounded entire auricles. The lobing of the lip is well towards the lower third of the labellum.

Experience of live plants of the taxon known as *T. tridentata* from North West Zambia and examination of the type of *T. filifolia* (Fig. 5, J) from Kew, plus a cross section of herbarium material from West, East and Central Africa shows that these plants should once again be separated from *T. tridentata* and placed under the oldest name *T. filifolia*.

***Tridactyle filifolia*** (Schltr.) Schltr. in Beih. Bot. Centralbl. 36, 2: 144 (1918) nomen reinstat. Type: Cameroun (Kamerun), Songa, Sept. 1899, *R. Schlechter* 12791 (B, holo ♀, K, iso.!) Fig. 5, J.

*Angraecum filifolium* Schltr. in West Afr. Kautschuk-Exped.: 284 (1900) and in Engl. Bot. Jahrb. 38: 21 (1905).



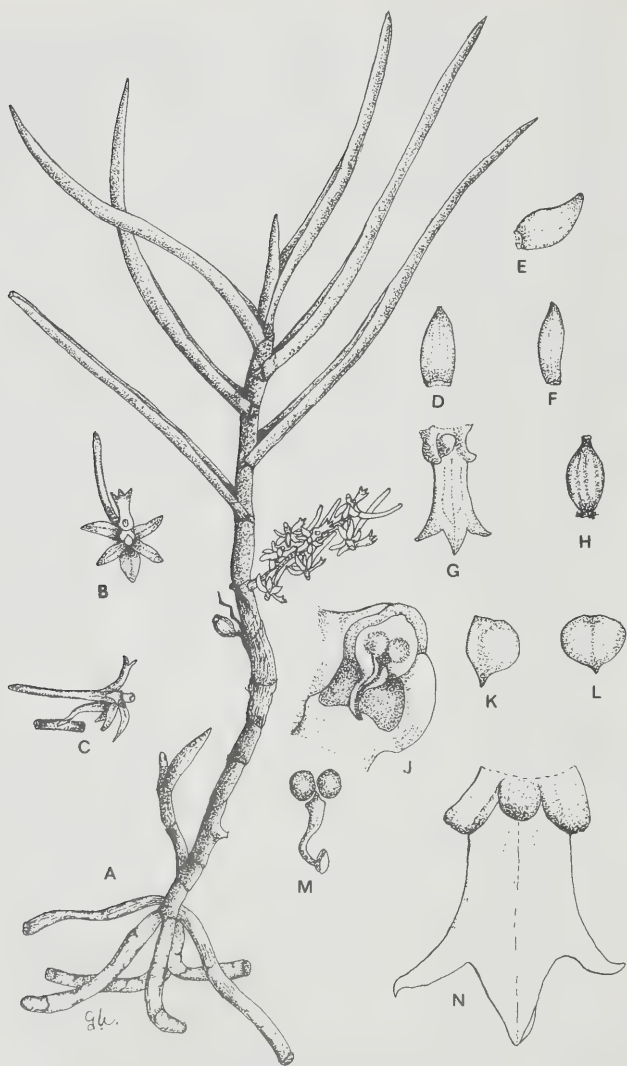


FIG. 4.

*Tridactyle tridentata*. A, habit,  $\times \frac{2}{3}$ ; B-C, flower,  $\times 1$ ; D, dorsal sepal,  $\times 3$ ; E, lateral sepal,  $\times 3$ ; F, petal,  $\times 3$ ; G, labellum,  $\times 4$ ; H, capsule,  $\times 2$ ; J, androclinium,  $\times 14$ ; K-L, anther cap,  $\times 14$ ; M, pollinarium,  $\times 10$ , A-M, from G. Williamson and R. B. Drummond 1739 (SRGH); N, labellum,  $\times 8$ , from a drawing by Lars Jonsson from the type collection of *Tridactyle teretifolia* Schltr. R. E. Fries 1273 (UPS). All magnifications are approximate.

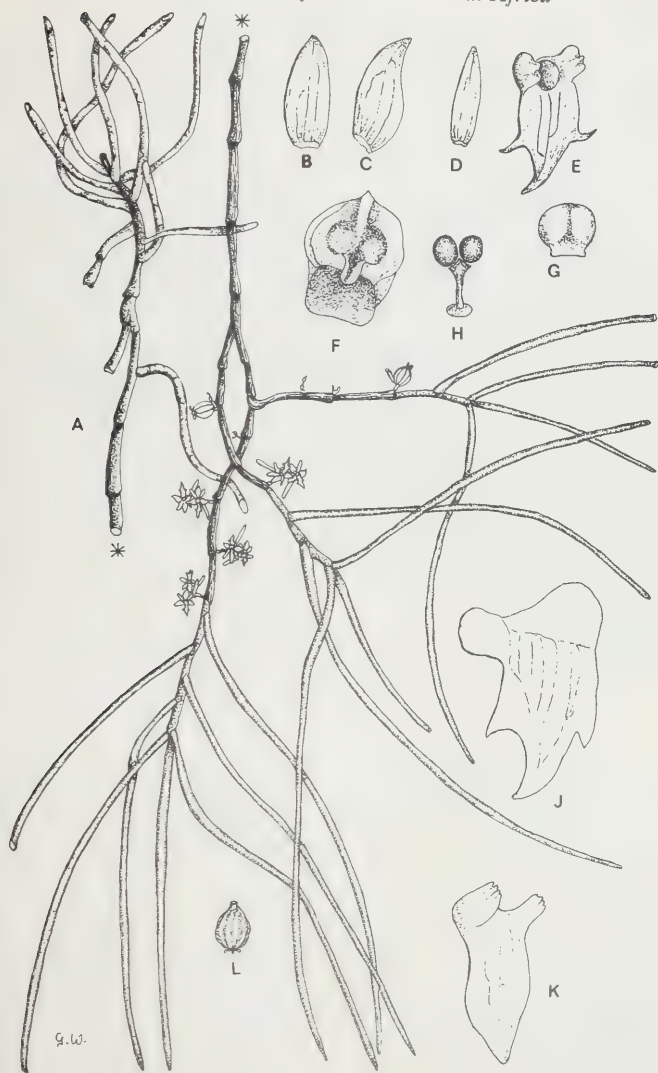


FIG. 5.

*Tridactyle filifolia*. A. habit,  $\times \frac{3}{8}$ ; B, dorsal, sepal,  $\times 8$ ; C, lateral sepal,  $\times 8$ ; D, petal,  $\times 8$ ; E, labellum,  $\times 10$ ; F, androclinium,  $\times 25$ ; G, anther cap,  $\times 25$ ; H, pollinarium,  $\times 25$ ; all from W. D. Holmes 0243 (SRGH); J, labellum,  $\times 15$ , from a tracing of a drawing by V. S. Summerhayes from the isotype of *T. filifolia* R. Schltr. 12791 (K); K, labellum, without lateral lobes,  $\times 14$ , from D. Johansson 591 (K). All magnifications are approximate.

*Tridactyle tridentata* (Harv.) Schltr. var. *subulifolia* Summerh. in K.B. 1948: 287 (1948), syn. nov. Type: Uganda, Busingiro, April 1943 and 1944, Eggeling 5277 (K, holo.!).

#### MATERIAL EXAMINED

GUINEA (Guynee): I.F.A.C. Daloba Futa Djallon on *Parinari excelsa*, Aug. 1962, P. Adames 332 (K); Amedzofe, forest at 2 000 feet—pendulous epiphyte, Oct. 1967, J.C. Bowling GC 36594 (K).

SIERRA LEONE: Several miles from Kameron on Karumbonla road, North. Prov., hanging epiphyte in fringing forest, Nov. 1965, J.K. Norton SL 3330 (K).

LIBERIA: Nimba Mtns. 600 m, Sanniquelle Distr., Aug. 1969, D. Johansson 591 (K).

NIGERIA: Gnitsha on Port Harcourt road, Aug. 1961, B.N. Okigbo (K).

CAMEROUN (KAMERUN): Songa, Aug. 1899, R. Schlechter 12791 (iso., K).

ZAÏRE: Garambo National Park, in gallery forest, Garambo River, Nov. 1951, H. de Saeger 1345 (K).

UGANDA: Budonga Forest, Oct. 1935, W. J. Eggeling 2235 (K).

KENYA: North Kavirondo Distr., Kakamega-Kaimosi road, Kakamega Forest, Oct. 1953, R.B. Drummond and J.A. Hemsley 4794 (K, SRGH).

ZAMBIA: West. Prov.: Mwinilunga Distr., epiphyte in evergreen forest patch, Nov. 1960, W.D. Holmes 0243 (SRGH); 80 km south of Mwinilunga on Kabompo road in *Cryptosepalum* forest, July 1963, J.P. Loveridge 748 (SRGH); same locality and date, T.B. Edwards 603 (SRGH).

The numerous characteristics that distinguish *T. filifolia* from *T. tridentata* are summarised below:

#### *T. filifolia* (Fig. 5)

#### *T. tridentata* (Fig. 4)

##### *Habit*

Pendulous, hanging in masses. Stems slender up to 500 mm long and usually not more than 2 mm in diameter, heavily branched.

Upright unless plant lank. Miniature form on Muchinga in Zambia grows downwards. Stems robust rarely more than 300 mm long and up to 5 mm in diameter and not as frequently branched.

##### *Leaves*

Up to 160 mm but only 2 mm or less at base. Very numerous forming a matted mass.

Leaves rarely more than 100 mm long but up to 5 mm across at base. Not as numerous.

##### *Inflorescences*

Numerous, up to 8 mm long, seldom with more than 4 flowers.

Fewer, up to 15 mm long or more with up to 8 flowers.

##### *Sepals*

Usually not more than 2,4 mm long but can be as small as 1,6 mm.

Never shorter than 2,5 mm but can be up to 4,2 mm long.

*Petals*

1,3 to 2 mm long with entire apex.

2,8 mm in the smallest forms but can be up to 4 mm long with occasional serrated apex.

*Labellum*

Overall length 1,5 mm to 2,9 mm, minutely toothed towards middle third, central lobe wider and longer than side lobes; side lobes occasionally vestigial (Fig. 5.K); auricles large compared with size of labellum, usually crenate, dentate or serrated. Spur up to 7 mm long.

Overall length from 3 mm to 6 mm, always tripartite towards apex with more or less triangular lobes; auricles always smooth, smaller compared with length of labellum than in *T. filifolia*. Spur always longer than 7 mm, up to 15 mm.

*Column*

Approximately 0,8 mm long.

Up to 2 mm long.

*Rostellum*

Rather straight and blunt.

Curved forwards and acute.

*Stipes*

Short and straight.

Long and curved to fit the rostellum. This feature is well illustrated in Bolus Icon. Orch. Aust. Afr. T.53.

*Habitat*

Closed canopy equatorial rain forest and relict gallery forest lining streams.

Open savanna woodland and rock face in full sun.

*Distribution*

Equatorial West Africa, East and Central Africa to North West Zambia.

More towards Eastern Africa from Kenya southwards to Eastern Cape Province in Repub. of S. Africa.

The two species meet in the Mwinilunga and Copperbelt Dist. of Zambia. Although growing adjacent to each other they never move out of their respective habitats.

Two taxa which Summerhayes put into synonymy with *T. tridentata* have not been included in this paper because they have not been investigated:

*T. goetzeana* (Kraenzl.) Schltr. in Engl. Bot. Jahrb. 53:602 (1915) as stated by Kraenzlin to have "Sepala petalaeque 1,5 mm longa, labellum vix longius, calcar 5-6 mm longum." These measurements would fall into the range of *T. filifolia*.

*T. linearifolia* (De Wild.) Schltr. in Beih. Bot. Centralbl. 36,2:144 (1918). Investigation of plants at (K) which Summerhayes placed within the range of this taxon viz. *Eggeling* 2235, match very well with specimens of *T. filifolia*.

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## CHROMOSOME NUMBERS OF SOUTHERN AFRICAN PLANTS: 1

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### VERBENACEAE

*Lantana camara* L.

*Lantana camara* L. is a poisonous but decorative alien that has become an aggressive invader of veld and plantations in southern Africa (Stirton, 1979; Wells & Stirton, 1981).

This brief report confirms the suspicion (Stirton, 1977) that this species comprises a polyploid complex in southern Africa.

$2n = 22$

TRANSVAAL—2330 (Tzaneen): near Tzaneen (-CC), *Stirton* 5760, 5784 (PRE).

—2528 (Pretoria): Pretoria North (-CA), *Stirton* 7231 (PRE).

—2531 (Komatipoort): near Witrivier (-AA), *Stirton* 7062, 7066, 7068, 7069, 7071, 7101 (PRE); near Klipkoppies (-AC), *Stirton* 6882, 7288, 7289, 7290, 7292, 7293, 7294, 7295, 7296, 7297, 7298, 7299, 7300, 7301, 7302, 7303, 7304, 7305, 7306, 7307, 7308, 7309, 7310, 7311, 7314, 7315, 7316, 7317, 7328, 7330, 7331, 7332, 7334, 7336, 7338, 7339, 7340, 7342, 7343, 7345, 7361, 7369, 7370, 7371, 7374, 7389, 7390, 7395, 7396, 7397, 7399 (PRE).

$2n = 33$

TRANSVAAL—2330 (Tzaneen): near Tzaneen (-CC), *Stirton* 5759 (PRE).

—2531 (Komatipoort): near Witrivier (-AA), *Stirton* 7067 (PRE); near Klipkoppies (-AC), *Stirton* 6875, 6878, 6883, 7348, 7381, 7382, 7383, 7384, 7387, 7393, 7394, 7398 (PRE); near Nelspruit (-CC), *Stirton* 6837 (PRE).

$2n = 44$

TRANSVAAL—2330 (Tzaneen): near Tzaneen (-CA), *Stirton* 5710 (PRE).

—2428 (Nylstroom): near Nylstroom (-DA), *Stirton* 5704 (PRE).

—2430 (Pilgrim's Rest): near Pilgrim's Rest (-DD), *Stirton* 8723 (PRE).

—2528 (Pretoria): Pretoria North (-CA), *Stirton* 7229, 7230, 7233, 7234, 7236, 7237, 7242, 7252, 7253 (PRE).

—2530 (Lydenburg): near Nelspruit (-BD), *Stirton* 6822 (PRE).

—2531 (Komatipoort): near Witrivier (-AA), *Stirton* 7054, 7055, 7060, 7061,

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7064, 7065, 7084, 7087, 7089, 7102, 7104, 7351, 7359, 7377, 7378, 7410, 7411, 7412, 7413, 7416, 7426, 7427, 8700 (PRE); near Klipkoppies (-AC), Stirton 6877, 6879, 6881, 7267, 7270, 7312, 7379, 7380, 7385, 7388, 7392, 7408, 7409, 7433, 7434 (PRE); near Kaapmuiden (-CB), Stirton 6782, 6784, 6791 (PRE).

NATAL—2831 (Nkandla): near Eshowe (-CD), Stirton 5288 (PRE); near Eshowe (-DA), Stirton 5280 (PRE).

—2930 (Pietermaritzburg): near Pietermaritzburg (-CD), Stirton 5438 (PRE).

—2931 (Stanger): near Tugela Mouth (-AB), Stirton 5352 (PRE).

—3130 (Port Edward): near Port Edward (-AA), Stirton 5605 (PRE).

CAPE—3418 (Simonstown): near Gordons Bay (-BB), Stirton 5832 (PRE).

—3419 (Caledon): near Betty's Bay (-BD), Stirton 5831 (PRE).

—3422 (Mossel Bay): near Mossel Bay (-AA), Stirton 6324 (PRE).

$2n = 55$

TRANSVAAL—2531 (Komatipoort): near Witrivier (-AA), Stirton 7430, 7432 (PRE).

NATAL—2831 (Nkandla): near Eshowe (-CD), Stirton 5287 (PRE).

$2n = 66$

TRANSVAAL—2531 (Komatipoort): near Witrivier (-AA), Stirton 7058, 7431 (PRE).

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## DIE BOU EN ONTWIKKELING VAN DIE UNIFASIALE BLAAR VAN *TRITONIA* EN VERWANTE GENERA

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### ABSTRACT

#### STRUCTURE AND DEVELOPMENT OF THE UNIFACIAL LEAF OF *TRITONIA* AND RELATED GENERA

External morphological and anatomical studies of the leaves of several species of *Tritonia* (fam. Iridaceae) and species of the related genera *Crocasmia*, *Chasmanthe*, *Ixia* and *Zygotritonia* showed that most have the medianly flattened, ensiform unifacial leaf which is typical of the Ixioidae. In *Tritonia crisa*, *T. lancea* and *T. cooperi* aberrant variations of this leaf type occur in which the lamina is formed by two or four longitudinal flanges developing secondarily from the abaxial side of the primordium. The leaf of *Ixia* differs in the presence of a strand of sclerenchyma in the leaf margins. The leaf of *Zygotritonia* differs to such an extent that it is doubtful whether this genus is closely related to the other genera. Leaf development was examined in four species, and the sympodial and monopodial theories on the origin of the unifacial leaf are briefly discussed.

### UITTREKSEL

'n Uitwendig-morfologiese en anatomiese ondersoek van die blare van verskeie *Tritonia*-spesies (fam. Iridaceae) en enkele spesies van die naverwante genera *Crocasmia*, *Chasmanthe*, *Ixia* en *Zygotritonia* toon dat die meeste die tipiese mediaan-afgeplatte ensiforme unifasiale blaar van die Ixioidae het. By drie spesies, t.w. *Tritonia cooperi*, *T. crisa* en *T. lancea*, kom afwykende variasies van hierdie blaartipe voor, waar die lamina uit twee of vier lengteriwwe bestaan wat sekondêre uitgroeiels is van die abaksiale kant. Die blare van *Ixia* verskil in die aanwesigheid van sklerenchiemstringe in die blaarrande. Die blaar van *Zygotritonia* verskil anatomies soveel van die ander dat dit twyfelagtig is of hierdie genus wel na verwant is. Die blaarontwikkeling van vier spesies is ondersoek en die simpodiale en monopodiale teorieë oor die unifasiale blaarontwikkeling word kortliks bespreek.

### INLEIDING

Tydens 'n sistematiese hersiening van die genus *Tritonia* is interessante variasies van die swaardvormige (ensiforme) unifasiale blaar, soos tipies vir die subfamilie Ixioidae van die Iridaceae, by een seksie van *Tritonia* gevind. Aangesien die blaaranatomie van slegs 'n paar *Tritonia*-spesies

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voorheen ondersoek is (Napp-Zinn, 1973, 1974), is 'n uitgebreide ondersoek van 'n groot aantal *Tritonia*-spesies gedoen om 'n totale oorsig van die anatomiese blaarkenmerke van die genus te verkry. Ook is die blare van enkele naverwante genera ondersoek om vas te stel in hoeverre hulle van *Tritonia* verskil, en of die blare enige bruikbare kenmerke kan verskaf om die genera te onderskei.

'n Ondersoek van die blaarontwikkeling is ook gedoen om uitsluitel te probeer kry tussen die twee teorieë oor die ontogenie van die unifasiale blaar.

#### MATERIAAL EN METODE

Die volgende *Tritonia*-spesies is ondersoek, verteenwoordigend van al vyf seksies van die genus.

Uit seksie *Tritonia*: *T. squalida*, *T. deusta*, *T. dubia*; uit seksie *Pectinatae*\*: Al vier spesies, naamlik *T. crispa*, *T. lancea*, *T. cooperi* en *T. tugweli*; uit die monotipiese seksie *Teretifoliae*\*: *T. kamisbergensis*; uit seksie *Subcallosae*\*: *T. bakeri*, *T. flabellifolia*, *T. lineata*, *T. rubrolucens*; en uit seksie *Montbretia*: *T. karooica*\*, *T. securigera*, *T. laxifolia*, *T. florentiae*, *T. watermeyer*, *T. marlothii*\*.

Seksies en spesies wat met 'n asterisk aangedui is, is nuut en sal in 'n volgende artikel beskryf word.

Die volgende spesies uit naverwante genera is ondersoek: *Crocasmia aurea*, *C. paniculata*, *Chasmanthe aethiopica*, *Ixia scillaris*, *I. monadelpha*, *Zygotritonia nyassana*.

Die plante is in die vorige jaar uit hul natuurlike groeiplekke versamel en in 'n Stellenbosch-tuin oorgeplant. In enkele gevalle waar geen vars materiaal verkry kon word nie, is van herbarium-materiaal gebruik gemaak.

Slegs vryhandsneë is gebruik vir die anatomiese bou van die volwasse blare. Dwarssneë deur die blaarskede, blaardeel tussen die skede en die lamina, en min of meer middelhoogte van die lamina is met die gewone histochemiese reagense behandel. Die blaarontwikkeling van *T. deusta*, *T. laxifolia*, *T. cooperi* en *T. crispa* is ondersoek deur middel van disseksies onder die ontleedmikroskoop met vergrotings van tot vyftigmaal en mikrotomsneë 10 µm dik en gekleur met Heidenhain se hematoksilien. Die tekening is met behulp van 'n tekenbuis gedoen.

#### ONDERSOEK EN BESPREKING

##### TRITONIA: MORFOLOGIE

By al die ondersoekte spesies is die blare rydend en gewoonlik distieg gerangskik. Die meeste blare is grondstandig, vasgeheg aan die hoër knope van die knol. Die onderste gedeeltes van die blaarskedes is geslote en vorm

die knoltunicae. Effens hoër-op is die blaarskedes oop en bifasiaal. Nog hoër-op gaan hulle geleidelik oor tot die unifasiale lamina. Behalwe vir drie spesies van die seksie *Pectinatae* is die lamina mediaan afgeplat en swaardvormig (ensiform), soos tipies vir die sub-familie Ixiodeae (Fig. 1 a-c)—die sogenaamde “Schwertblätter” (Troll, 1939). Die lamina besit talryke parallelle are in pare teenoor mekaar geleë. In die middel is 'n groter aarpaar, die sogenaamde sekondêre middelnerf (Troll, 1939) of pseudo-middelaar (Napp-Zinn, 1974) wat homoloog is met twee laterale are van 'n bifasiale blaar. Die twee rande van die lamina is eenders, hoewel die rand verste van die as, dit wil sê die abaksiale rand (md in Fig. 1 b, c), gelyk is aan die middel van die bifasiale blaar en die rand naaste aan die as die twee rande van die bifasiale blaar voorstel (mv in Fig. 1 c).

Hoër op die stingel kom enkele stingelblare voor wat kleiner is as die basale blare. Hulle is grotendeels bifasiaal, behalwe vir 'n langer of korter unifasiale voorloperspits aan die top (vgl. Troll, 1939).

Die katafils wat vóór die loofblare rondom die groeipunt op die knol ontwikkel, is ook grotendeels bifasiaal. Hulle is efemeer by *Tritonia* en vergaan gewoonlik nadat hulle hul funksie, naamlik die beskerming van die groeipunt en later die spruitende loofblare, verrig het.

By die volgende drie *Tritonia*-spesies kom variasies van die tipiese swaardvormige unifasiale blaar voor:

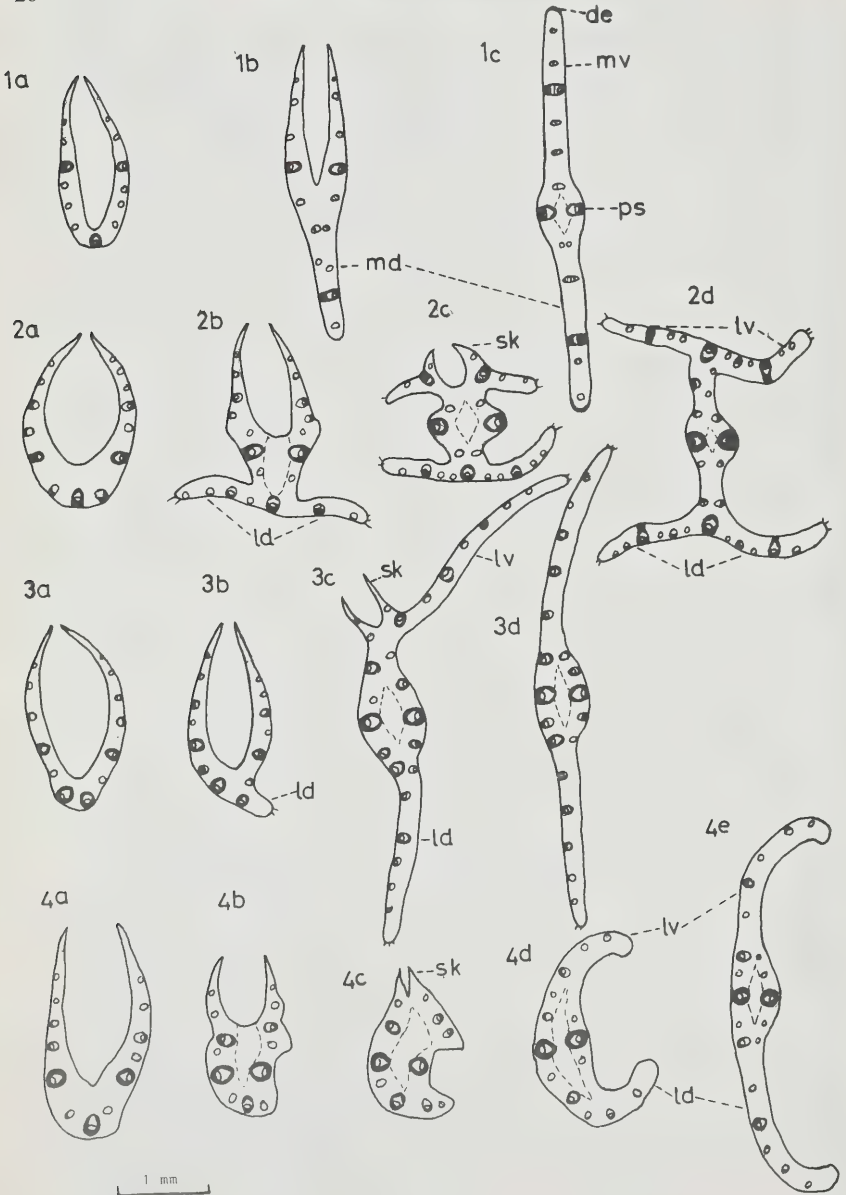
(i) *T. cooperi*. Die lamina besit vier oorlangs verlopende vleuels en is H-vormig in dwarsnee (Fig. 2 d), met die dwarsbalkie van die H in die mediane lyn, en twee vleuels en 'n breë groef aan elke kant van die mediaan. In die mediane lyn halfpad tussen die twee adaksiale vleuels het die rande van die bifasiale blaarskede laer-af verdwyn (Fig. 2 b-d). Die vier vleuels is laterale uitgroeisels van die abaksiale blaaroppervlakte. Hulle word hier die latero-ventrale (naaste aan die as) en latero-dorsale (verste weg) genoem (lv en ld in Fig. 2 d).

Soortgelyke H-vormige unifasiale blare is ook by *Romulea hirta* en *R. tetragona* gevind (De Vos, 1970). Hierdie blare verskil egter van dié van *Gladiolus tristis* waar twee vleuels in die mediaane lyn lê en twee lateraal (Arber, 1925).

Die lamina van die volgende twee spesies is herleibaar van die H-vormige blaartipe van *T. cooperi*.

(ii) *T. crispa*. Uitwendig lyk die blaar na 'n tipiese swaardvormige unifasiale blaar (Fig. 3 d). Trouens, die abaksiale helfte daarvan lyk asof dit homoloog kan wees met die mediane abaksiale helfte van *T. cooperi*, behalwe dat die are in 'n enkele ry voorkom en nie in opponerende pare nie. Ondersoek toon egter dat hierdie vleuel nie werklik mediaan aangelê is nie, maar 'n uitgroeisels langs die mediane lyn is (Fig. 3 b). Dit is homoloog met die regter latero-dorsale vleuel van *T. cooperi*, hoewel dit effens nader aan die





mediane lyn van die blaar geleë is (Fig. 3 b). Die blaarhelfte naaste aan die as (lv in Fig. 3 c) is ook 'n nuwe interkalêre ontwikkeling en stel nie die twee rande van die blaarskede voor nie. Die laasgenoemde het laer af, waar die lamina begin, verdwyn (Fig. 3 b, c), soos by *T. cooperi*. Hierdie blaarhelfte is homoloog met die regter latero-ventrale vleuel van *T. cooperi*.

(iii) *T. lancea*. Die lansetvormige lamina lyk ook uitwendig na die swaardvormige radiaal-afgeplatte lamina van die Ixiodeae, behalwe dat die rande daarvan omgerol is na een sy (Fig. 4 e), en dat die blaar tot 'n smal blaarsteelagtige gedeelte vernou is tussen die skede en die lamina. (Fig. 4 c). Die "blaarsteel" is dus ook unifasiaal met 'n oppervlakte grootliks homoloog met die abaksiale epidermis van die blaarskede (Fig. 4 b, c). Op 'n hoogte waar die rande van die skede nog onderskeibaar is, is twee uitgroeisels aan die een kant van die "blaarsteel" te sien (Fig. 4 b, c). Hoër-op verbreed hulle geleidelik en ontwikkel tot die lansetvormige lamina met sy omgerolde rande en sterk pseudo-middelaar (Fig. 4 d, e). Hierdie lamina is dus ook, net soos dié van *T. crispa*, homoloog met die twee vleuels aan die regter kant van die blaar van *T. cooperi*.

## ANATOMIE

Die lamina van die swaardvormige unifasiale blare is, soos te verwagte, isobilateraal wat betref die epidermis, mesofil en vaatweefsel.

By *T. cooperi*, *T. crispa* en *T. lancea* egter is slegs die middelstuk van die lamina, wat die pseudo-middelaar bevat, isobilateraal. Die vleuels van die eersgenoemde soort en die blaarhelftes van die ander twee soorte verskil aan hul twee kante in epidermissel-grootte, huidmondjie-getalle en die posisie van die vaatbundels. Daar kan selfs met die blote oog gesien word dat die twee kante van die blare van *T. crispa* en *T. lancea* nie eenders is nie, weens 'n verskil in die intensiteit van die groen kleur.

*Epidermis*. Hierdie selle is betreklik groot en dunwandig en is eenders aan die twee kante van die lamina behalwe by die drie bogenoemde spesies: by *T. cooperi* is hulle groter in die twee groewe van die lamina en het hulle daár dunner wande as elders op die blaar; by *T. lancea* is die selle effens breër aan die kant weg van die verdwynende blaarskede en kom hier, asook

FIG. 1-4.

*Tritonia*-spesies, dwarsneë deur volwasse blare.

Fig. 1, *T. securigera*: 1 a, blaarskede; 1 b, 'n hoogte tussen blaarskede en lamina; 1 c, lamina. Fig. 2, *T. cooperi*: 2 a, blaarskede; 2 b, 2 c, twee hoogtes tussen skede en lamina; 2 d, lamina. Fig. 3, *T. crispa*: 3 a, blaarskede; 3 b, 3 c, twee hoogtes tussen skede en lamina; 2 d, lamina. Fig. 4, *T. lancea*: 4 a, blaarskede; 4 b-4 d, drie hoogtes tussen skede en lamina; 4 c, "blaarsteel"; 4 e, lamina.  
de, versterkte epidermis van blaarrand; ld, latero-dorsale vleuel; lv, latero-ventrale vleuel; md, mediaan-dorsale kant; mv, mediaan-ventrale kant; ps, pseudo-middelaar; sk, verdwynende blaarskede. Slegs die groot are word getoon; swart, sklerenchiem.

by *T. crisper*, meer huidmondjies voor as aan die ander kant (ca. 15–17 teenoor 11–12 huidmondjies per  $0,05 \text{ mm}^2$ ). Die blare van hierdie drie spesies is in staat om tydens waterskaarste effens toe te rol, sodat die kante met die dunner selwande en groter getalle huidmondjies tot 'n mate beskerm is.

By die seksie *Tritonia* en die meeste ondersoekte spesies van seksie *Montbretia*, asook by *T. flabellifolia* en *T. lineata*, kom twee tot vyf epidermale papille in 'n ry, of soms slegs een, op die epidermisselle voor. Soos by verskeie ander genera van die Iridaceae, onder andere *Romulea* (De Vos, 1970), is die papille soliede verdikkings van die sellulosewand onder die dun kutikula. 'n Uitsondering is *T. lancea* waar die papille, wat hier slegs aan die een kant van die lamina voorkom, breed is en uit 'n groepie gekutiniseerde stafies bestaan wat vanaf die kutikula in die selluloselaag instulp (Fig. 5).

'n Toets vir tannien met fosfomolibdiensuur (Dugdale, 1971) toon by die meeste spesies die aanwesigheid van tannienverbindinge in ongeveer 50 persent of meer van die epidermisselle, uitgesonderd die epidermisgedeeltes teenoor die groot are en op die blaarrande. Die groot hoeveelheid tannien in die epidermis van *T. lineata* en *T. rubrolucens* veroorsaak dat die blare van herbariumeksemplare van hierdie spesies bruin of donkerbruin is. Die enigste soorte sonder tannien in die epidermis is dié van die seksie *Pectinatae*, asook *T. bakeri*.

Effens ingesinkte huidmondjies, sonder hulselle, kom op die kostale streke van die lamina voor. 'n Gewone epidermissel en 'n huidmondjie wissel mekaar taamlik reëlmatig af. (Fig. 6).

Die blaarrande is van drie tipes: By die meeste spesies is die blaarrandepidermis die versterkingsweefsel, met hoë, baie smal selle en met die antiklinale selwande tot so 'n mate verdik dat die sellumen in sommige gevalle byna geöblitereer is (Fig. 7). Die selwande is egter nie verhout nie. By *T. florentiae*, *T. watermeyeri*, *T. karooica*, *T. bakeri*, asook by *T. cooperi*, *T. crispa* en *T. lancea*, verskil die blaarrandepidermis nie veel van die gewone epidermis nie. In die drie laasgenoemde spesies egter, is elke blaarrandepidermissel uitgestulp en vorm dit 'n kort eensellige trichoom (Fig. 10). Hierdie is die enigste spesies met trichome.

*Mesofil.* Die chlorenchiem onder die twee oppervlaktes is diggepak, sonder groot intersellulêre ruimtes, en by die meeste spesies is die selle in die breedte van die blaar verleng. Dit beteken dat die lamina laat in sy ontwikkeling, nadat seldeling opgehou het, nog breër word deur verbreding van die selle. Uitsonderings met palissadechlorenchiem is by spesies vanuit die Karoo en Namakwaland gevind, naamlik by *T. kamisbergensis*, *T. karooica* en *T. florentiae*.

'n Kleurlose waterbergende parenchiem kom voor tussen die twee

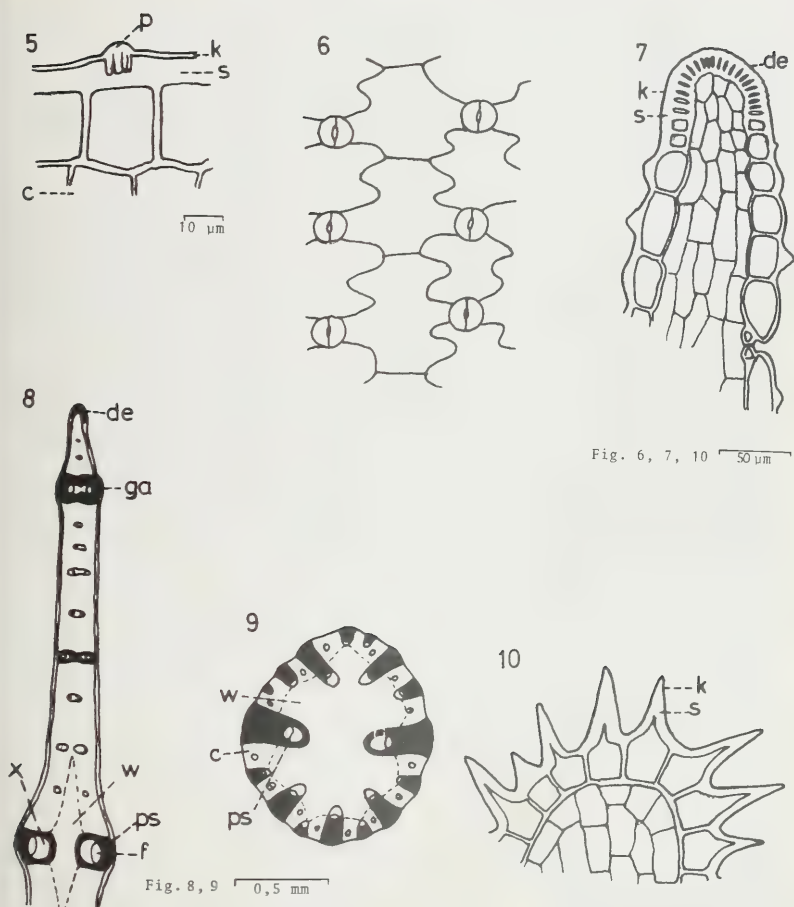


FIG. 5-10.

*Tritonia*-spesies, blaaranatomie.

Fig. 5, *T. lancea*, epidermis. Fig. 6, *T. deusta*, epidermis en huidmondjies. Fig. 7, *T. crocata*, blaarrand. Fig. 8, *T. lineata*, dwarssnede deur helfte van die lamina. Fig. 9, *T. kamisbergensis*, dwarssnede deur die lamina. Fig. 10, *T. crista*, blaarrand.

c. chlorenchiem; de, dikwandige epidermis van die blaarrand; f. floëem; ga, groot aar naby die blaarrand; k, kutikula; p. papil; ps, pseudo-middelaar; s, sellulosewand van epidermis; w, waterbergende parenchiem; x, xileem. Swart, sklerenchiem.

pseudomiddelare, onder andere by *T. cooperi*, *T. flabellifolia* en *T. kamisbergensis*. By *T. bakeri*, wat 'n effens verdikte lamina het, strek dié weefsel ook na weerskante.

Groot hoeveelhede ronde of ovale, dunwandige tannienbevattende idioblaste kom voor in die kleurlose sentrale parenchium. By *T. kamisbergensis* is hierdie idioblaste in die chlorenchium gekonsentreer.

Soos tipies vir die Iridaceae, kom lang spiesvormige styloiede van kalium-oksalaat algemeen voor, in die mesofil versprei en teen die sklerenchiemstringe van die are.

Subepidermale sklerenchiem is afwesig in die blaarrande, behalwe vir enkele vels by *T. securigera*, en by *T. marlothii* waar in elke rand 'n volledige aar (die dorsale en ventrale are respektiewelik) met sy sklerenchiemkappie voorkom.

*Vaatweefsel.* Die talryke are, in opponerende pare gerangskik, lê met die floëem na buite gekeer en die xileem na binne (Fig. 8). By die drie spesies van die seksie *Pectinatae* egter, is slegs die middelste deel van die lamina presies isobilateraal, waar die paar grootste are, asook enkele kleineres, teenoor mekaar lê (Fig. 2 d, 3 d, 4 e). In die vier vleuels van *T. cooperi* en die twee blaarhelftes van *T. crispa* en *T. lancea* kom die are in 'n enkele ry voor, met die floëem na die kleiner-sellige epidermis gerig en die xileem na die kante waarnatoe die blaarrande kan omrol tydens waterskaarste. Dit wil sê 'n sekondêre dorsiventraliteit is hier aanwesig.

Groot aarpere is meestal met 'n breë sklerenchiemskede omring, of besit sklerenchiemkappies tussen die floëem en epidermis. Kleiner are, sonder sklerenchiem, is dikwels diep in the mesofil geleë. Parenchimatiese bundelskedes is nie duidelik te onderskei nie.

*T. lineata* en *T. rubrolucens* besit naby elke blaarrand 'n paar groot laterale are met sklerenchiemskedes (Fig. 8). Hulle is veral in herbariummateriaal duidelik sigbaar en verskaf 'n kenmerk om hierdie spesies te onderskei. 'n Mediaan-ventrale en -dorsale aar soos by ander swaardvormige unifasiale blare in the blaarrand aangetref (Kaplan, 1970; Fig. 1) kom nie voor nie, behalwe by die Namakwalandse spesies *T. kamisbergensis* en *T. marlothii*.

Die filiforme blaar van *T. kamisbergensis* is verder uitsonderlik in die besit van groot, massiewe sklerenchiemkappies teenoor die groot are, wat die chlorenchium in aparte stroke skei (Fig. 9). Met uitdroging krimp die mesofil sodanig dat die sklerenchiem as uitbultende lengteriwwe in herbariummateriaal te sien is. Weens die terete vorm van die blaar lê die are in 'n kring gerangskik.

### CROCOSMIA EN CHASMANTHE

Die ondersoekte spesies van hierdie genera se blare stem ooreen met die mediaan-afgeplatte swaardvormige blaar van *Tritonia* in hul presies isobi-



laterale lamina met twee rye opponerende are, die afwesigheid van 'n mediaan-dorsale en -ventrale aar in die blaarrande, en in die aard van die mesofil en die epidermis met sy papille en effens ingesinkte huidmondjies; ook in die bou van die blaarrande waar die verdikte epidermis die enigste versterkingsweefsel van die rand is.

## IXIA

Die ondersoekte *Ixia*-spesies verskil in die aanwesigheid van 'n sub-epidermale sklerenchiemstring, sonder begeleidende aar, in elke blaarrand. Hierdie versterkte rande is uitwendig met die blote oog sigbaar en verskaf 'n kenmerk wat bykomend gebruik kan word in die identifkasië van twyfelagtige gevalle. So toon die blaar van *I. scillaris*, wat voorheen onder *Tritonia* ingedeel is, die blaarrand van 'n *Ixia*; terwyl *Tritonia dubia*, wat morfologiese kenmerke van beide genera het, die tipiese *Tritonia*-blaarrand besit.

## ZYGOTRITONIA

Die unifasiale blaar van *Z. nyassana*, die enigste spesie wat van dié genus ondersoek is, verskil soveel van die tipiese *Tritonia*-blaar dat twyfel kan bestaan of dit wel in die *Tritonia-Crocasmia-Chasmanthe*-groep tuishoort. (Die spesie is eers as 'n *Tritonia* beskryf, maar is deur Mildbraed (1923) na 'n aparte genus oorgeplaas.) Slegs herbariummateriaal was beskikbaar vir die huidige ondersoek, en nieteenstaande die ouderdom daarvan, was die volgende verskille duidelik: die pseudo-middelaar bevat twee pare are, elke paar bestaande uit 'n groot en 'n klein aar; die blaarrande is verdik en besit drie groot are elk; in groot dele van die blaar is die twee rye are nie in pare nie; die epidermis van die twee kante verskil in selgrootte en dikte van die buitewande; op die blaarrande asook op sommige van die groot are kom trichome met verbrede basisse voor. 'n Verdere studie van vars materiaal is nodig.

## BLAARONTWIKKELING

### *Die katafils*

Reeds vóór die russeisoen intree, ontstaan by al vier ondersoekte spesies 'n paar klein katafilprimordia in 'n distiege rangskikking weerskante van die groepunt op die jong knol. So 'n primordium verbreed deur marginale groei en omarm die knolgroepunt geleidelik. Gelyktydig hiermee groei die top van die primordium in 'n adaksiale rigting en vorm dit 'n klein verdikte mussie wat bo-oor die groepunt welf. Aan die top van die mussie ontwikkel 'n klein riffie wat 'n beperkte groei het van skaars 100  $\mu\text{m}$ . Dit is effens gekiel en afgeplat in die mediane vlak van die primordium, en stel die unifasiale voorloperspits (Troll, 1939) voor. In die basis van die primordium

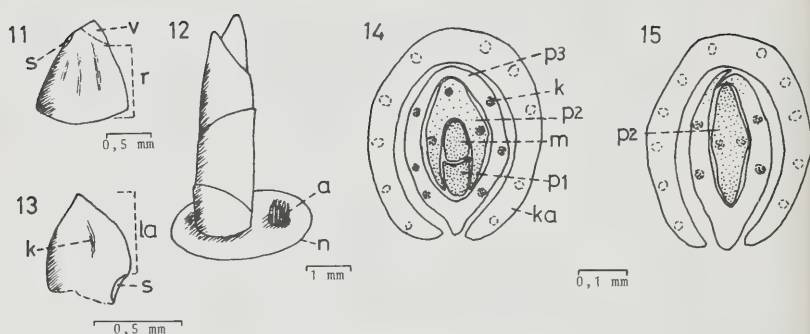


FIG. 11-15.

*Tritonia*-spesies, blaarontwikkeling

Fig. 11, *T. laxifolia*, tweede katafilprimordium van rustende knop, van buite gesien. Fig. 12, *T. laxifolia*, spruitende knop met verlengende katafils. Fig. 13, *T. laxifolia*, jong loofblaarprimordium van spruitende knop, van buite gesien. Fig. 14, 15, *T. deusta*, dwarsnee deur spruitende knop, met die meeste katafils verwyder, met Fig. 15 120  $\mu\text{m}$  bo Fig. 14.

a, oorblyfsel van vorige jaar se as; k, prokambiumstring; ka, katafil; la, jong lamina; m, knopgroeipunt; n, boonste knoop op die knol; p 1-p 3, loofblaarprimordia; r, basale ringwal van katafil; s, blaarskederande; v, unifasiale voorloperspits. Stippeling toon meristematieese aktiwiteit.

vind interkalêre groei plaas waardeur die knolgroeipunt met 'n geslote ringwal omring word en die primordium bo-op die geslote ringwal opgedra word. Die primordium toon 'n klein spleet onder die voorloperspits, waar sy rande nie vergroei het nie (Fig. 11).

Ongeveer drie sulke katafils ontwikkel en bedek die groeipunt van die knol gedurende die russeisoen, in die vorm van klein mussies 1-1,5  $\mu\text{m}$  hoog, die een bo-oor die ander gestrek.

Aan die begin van die groeiseisoen vind verdere groei van die katafils plaas, grootliks deur selverlenging in die basale ringwal (Fig. 12). Die oudste katafils verleng nie veel nie omdat hulle reeds gou uit volwasse weefsel bestaan wat gelerig word en doodgaan. Elke volgende katafil van die reeks, wat nou tot vyf vermeerder het, verleng en bars met sy spits ruffie (voorloperspits) deur die blaarskedespleet van die vorige een. Die jongste katafils word verskeie sentimeter lank en groei tot hul punte bo die grond verskyn, om sodoende die jong loofblare in hul weg deur die grond te beskerm.

*Die loofblare*

Eers aan die begin van die groeiperiode ontstaan die loofblare. Hul ontwikkeling is grootliks soos dié van die katafils, met die verskil dat die plat unifasiale ruffie aan die top van die primordium vinnig verleng en deur die

skede-spleet van die hoogste katafil bars om die lang unifasiale lamina te vorm, en dat die basale ringwal eers later ontwikkel. Omdat dit as 'n gekielde riffie ontstaan, is die lamina-primordium van *T. deusta* en *T. laxifolia* vanaf die begin afgeplat in die mediane vlak (Fig. 15). Dit verbreed, veral by *T. deusta*, eers deur aanhoudende seldeling in sy ad- en abaksiale rande, en later deur selekstensie, om die linêr-lansetvormige lamina te vorm. Die ad- en abaksiale blaarhelftes word ewe breed. Later is die groei (verlenging) van die lamina beperk tot die basis daarvan.

Die blaarskede-ontwikkeling is ook later basaal; die basale ringwal vorm 'n geslote blaarskedebasis, en die oorspronklike bifasiale blaarprimordium vorm die lang oop gedeelte van die skede.

By *T. crispa* begin daar reeds vroeg, wanneer die blaarprimordium nog skaars 350  $\mu\text{m}$  lank is en die laminaprimordium omtrent 250  $\mu\text{m}$ , 'n sterker meristematiese aktiwiteit op twee stroke in die regter kant van die abaksiale oppervlakte van die laasgenoemde (Fig. 19, 20). Hierdeur ontwikkel twee lengteriwwe. Hulle bly 'n tydlank meristematies en word al breër, waardeur hulle genoodsaak word om op hulself om te krul, weens die klein ruimte wat beskikbaar is terwyl die jong lamina nog deur die beskermde katafils omring word (Fig. 21).

Die ab- en adaksiale verbreding van die lamina soos in *T. deusta* en *T. laxifolia* aangetref, vind hier nie plaas nie. Dit is vervang deur die twee lengteriwwe wat tot die twee laminahelftes ontwikkel.

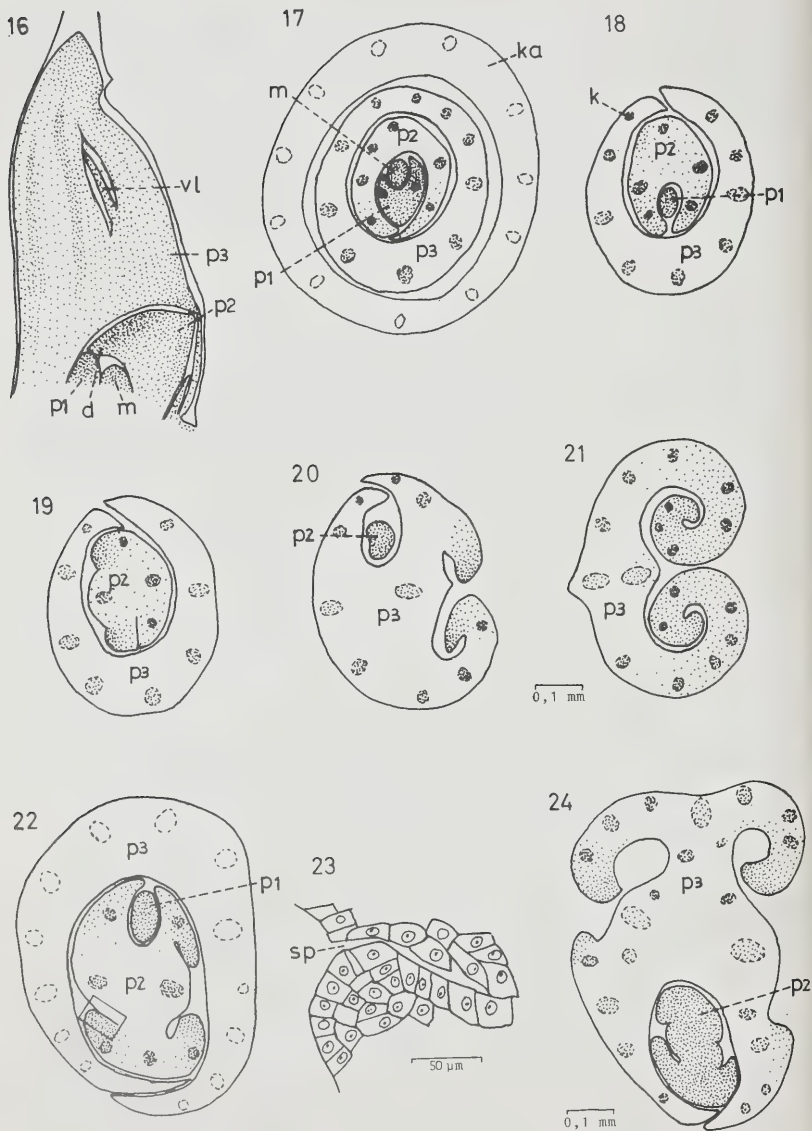
Dieselfde gebeur met die ontwikkeling van die *T. cooperi*-blaar, behalwe dat vier riwwe ontstaan, twee regs en twee links van die mediane lyn, om die vier vleuels van die volwasse blaar te vorm (Fig. 22, 24). Die twee laterodorsale vleuels begin effens vroeër ontwikkel as die ander twee.

In dwarsneë lyk dit plek-plek of die ontwikkeling van die vier vleuels aanvanklik gepaard gaan met die vorming van 'n intersellulêre skeurtjie langsaaan die sones van sterker meristematiese aktiwiteit (Fig. 22, 23).

Die blaarontwikkeling van *T. crispa* en *T. cooperi* staaf dus die interpretasie wat aan die volwasse blare van hierdie spesies gegee is—sien onder MORFOLOGIE.

Die vroeë blaarontwikkeling van *T. deusta* en *T. laxifolia* stem ooreen met dié van *Iris ochroleuca* (Thielke, 1948) en tot 'n sekere mate met *Acorus calamus* (Kaplan, 1970). Die interpretasie wat hierdie twee werkers aan die ontwikkeling heg, verskil egter. Thielke interpreteer dit volgens die sogenaamde simpodiale teorie waarvolgens die oorwelwing van die groeipunt deur 'n hiponastiese groei van die apikale meristeem van die blaarprimordium plaasvind, en 'n sogenaamde sekondêre apikale meristeem op die abaksiale rug van die gewelfde primordium die unifasiale lamina vorm (Fig. 25 a-d).

Hierdie teorie is deur Troll (1955) en Kaplan (1970, 1975) gekritiseer.



beide voorstanders van die monopodiale teorie. Hulle meen dat die oorwelwing van die groeipunt deur 'n adaksiale verdikkingsmeristeem of "Rundungsmeristem" (Troll) plaasvind waardeur 'n kussinkie oor die groeipunt gevorm word, en dat die apikale mediane riffie waaruit die unifasiale lamina ontstaan, die werklike primêre apikale meristeem van die primordium is (Fig. 25 e-h). Die voordeel van hierdie teorie is dat dit die ontwikkeling van die unifasiale blaar nader aan dié van die bifasiale blaar bring.

In die huidige ondersoek kan nie uitsluitel gegee word tussen die twee teorieë nie. Nogtans blyk die volgende:

By *T. laxifolia* en *T. deusta*, en waarskynlik ook ander lede van die genus en die subfamilie Ixiodeae, word die jong adaksiale blaarhelfte gevorm bokant en uit selrye wat direk afkomstig is van die adaksiale verdikkingsmeristeem (Fig. 16), en nie soos by *Acorus calamus* nie (Kaplan, 1970, Fig. 44-47), waar die blaarprimordium bokant die verdikkingsmeristeem baie smaller word as by laasgenoemde, en hierdie meristeem skynbaar nie deel het aan die vorming van die adaksiale deel van die lamina nie. Dit beteken dat volgens die monopodiale teorie die lamina van *Tritonia* dan nie geheel-en-al unifasiaal sou wees nie (omdat die verdikkingsmeristeem as 'n adaksiale uitgroei sel beskou kan word). Dit is jammer dat Kaplan in sy uitgebreide ondersoek van unifasiale blare van monokotiele (1975) nie ook 'n swaardvormige blaar van een van die Ixiodeae ondersoek het nie.

Vir my wil dit voorkom dat die vroeë oorwelwing van die stingel-groeipunt deur die groei van die rand reg rondom die blaarprimordium plaasvind—vergelyk ook Kaplan, 1970, Fig. 11-15 vir *Acorus calamus*. Dit sou as 'n gekombineerde apikale-en-marginale groei beskou kan word (dit is bekend dat apikale en marginale groei by die monokotielblare nie goed van mekaar te onderskei is nie). Myns insiens was dit eintlik onnodig om die term sekondêre meristeem wat Thielke gebruik vir die meristeem wat vir die verlenging van die lamina sorg, in te voer. Dit kan as deel van die primêre apikale meristeem beskou word, wat slegs effens na die abaksiale kant verskuif is. Aanvanklik is die twee meristeme baie na aan mekaar.

#### FIG. 16-24.

##### *Tritonia*-spesies, loofblaarontwikkeling.

Fig. 16, *T. crispa*, byna-mediane lengtesnee deur 'n spruitende knop. Fig. 17-21, *T. crispa*, reeks dwarssnee van 'n spruitende knop; hoogtes bo knopgroeipunt: Fig. 18, 25 µm; Fig. 19, 50 µm; Fig. 20, 80 µm; Fig. 21, 500 µm. Fig. 22-24, *T. cooperi*, dwarssnee deur 'n spruitende knop: Fig. 22, 20 µm bo knopgroeipunt; Fig. 23, vergroting van linker latero-dorsale vleuel van Fig. 22; Fig. 24, 400 µm bo knopgroeipunt.

d, verdikkingsmeristeem; ka, jongste katafil; k, prokambiumstring; m, knopgroeipunt; p 1-p 3, loofblaarprimordia; sp, spleet langs anlage van vleuel; vd, verdikkingsmeristeem; vl, vleuel van lamina raakgesny. Stippeling toon meristematieese aktiwiteit.



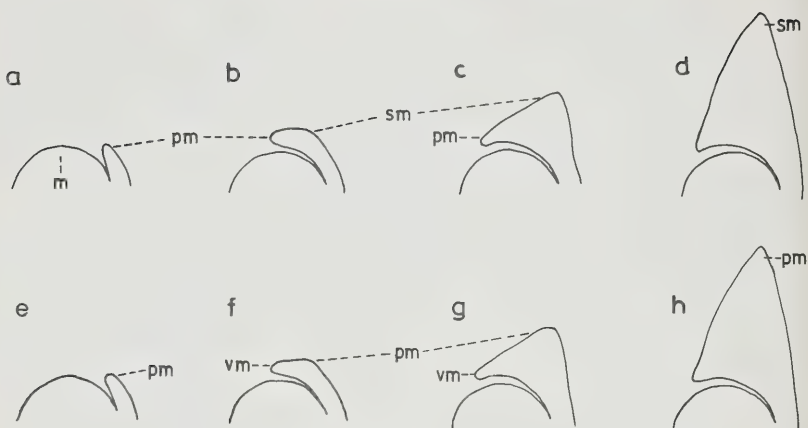


FIG. 25.

Interpretasie van die unifasiale blaarontwikkeling: a-d, volgens die simpodiale teorie; e-h, volgens die monopodiale teorie.

m, stingelgroeiapunt; pm, apikale meristeem van die blaarprimordium; sm, sekondêre apikale meristeem; vm, adaksiale verdikkingsmeristeem.

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## SYSTEMATICS OF *FREESIA* KLATT (IRIDACEAE)<sup>1</sup>

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### ABSTRACT

*Freesia* is a small genus of southern African Iridaceae subfamily Ixiodeae, here treated as comprising 11 species. The genus is divided into two sections based on tepal and bract morphology, section *Freesia* with dry bracts and cordate inner tepals, and section *Viridibractea* with green bracts. Species are concentrated in the southern Cape Province, in the Cape Floristic Region, but *F. andersoniae* occurs outside this area, in the Karoo, northern Cape and Orange Free State. Based on morphological and cytological grounds, *Freesia* is believed to be closely allied to *Anomatheca*, but other affinities are unknown. The genus was last revised in 1935 when 19 species were recognised, this number here substantially reduced. Taxonomic and horticultural history is reviewed in detail and several original chromosome counts are presented.

### UITTREKSEL

#### DIE SISTEMATIEK VAN *FREESIA* KLATT (IRIDACEAE)

*Freesia* is 'n klein geslag van die Suider-Afrikaanse Iridaceae, subfamilie Ixiodeae, en word hier behandel as bestaande uit 11 soorte. Die genus word in twee seksies onderverdeel op grond van dek- en skutblaar morfologie; seksie *Freesia* met droë skutblare en hartvormige binne deklare en seksie *Viridibractea* met groen skutblare. Die soorte is gekonsentreer in die Suidelike Kaapprovinsie in die Kaapse Floristiese Streek, maar *F. andersoniae* kom buite die area voor; in die Karoo, Noord Kaap en Oranje-Vrystaat. Op morfologiese en sitologiese gronde word aanvaar dat *Freesia* naverwant is aan *Anomatheca* maar ander verwantskappe is onbekend. Die geslag is laas in 1935 hersien en 19 soorte is toe erken. Die getal word nou aansienlik verminder. Taksonomiese getal en tuinboukundige geskiedenis word in besonderhede bespreek en verskeie oorspronklike kromosoomtellings aangebied.

### INTRODUCTION

It is now some 45 years since N. E. Brown's important revision of *Freesia* was published (Brown, 1935). This work was significant as the first revision of a genus of Iridaceae published since *Flora Capensis* (Baker, 1896) and *Flora of Tropical Africa* (Baker, 1898) and one of the first revisions of any African genus in a recognizably modern format in which detailed attention was paid to the early literature and especially to typification. In South Afri-

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ca, Brown's treatment provided the model for the excellent revisions and monographs of genera of Iridaceae by G. J. Lewis, published from 1941 onward, culminating in her study of *Gladiolus* published posthumously (Lewis *et al.*, 1972). In a broader sense, Brown's revision of *Freesia* formed a model for systematic studies in many other groups of southern African plants.

It has nevertheless become evident that Brown's revision, however valuable as a model, failed in two important respects. First, he failed to relate several so-called species known only in cultivation, either in Europe or South Africa, to wild plants, so that in recognizing "nineteen species native in South Africa" he substantially overestimated the true number of wild species. Second, too little herbarium material was known at the time to reasonably assess the degree of variation within species, so that Brown inevitably tended to oversplit species in a genus where differences even between distantly related species are now perceived to be very small.

In the present treatment, I recognize eleven species of *Freesia*, all known in the wild. Where I have been unable satisfactorily to relate species described from cultivated plants to wild forms, as in *F. gentilis* N.E. Br. and *F. picta* N.E. Br. I have taken the view that these are either horticultural forms or in the case of *F. xanthospila* and *F. herbertii* most probably poorly grown plants too abnormal to be correctly related to any wild species. I doubt that wild plants exist, as yet undiscovered, to which these species names can be applied.

#### TAXONOMIC HISTORY

Species of *Freesia* first found their way to Europe in the mid-seventeenth century, a time of rising interest in Cape plants. Burman, in 1768, described two, both from cultivation, placing one in *Gladiolus*, namely *G. corymbosus* and the other in *Ixia*, *I. caryophyllacea*. The placement in different genera reflected differences in the degree of zygomorphy, which were at that period regarded as generically significant.

A third species was named by Jacquin in 1795, also apparently in cultivation, this being *F. refracta*, which was assigned, like *F. corymbosa*, to *Gladiolus*. Another species was described by De Candolle from plants grown in Paris, *F. xanthospila*, and figured in Redouté's *Liliacées* in 1807, and also placed in *Gladiolus*. I am unable to relate this species to any wild plant, but suspect it may be a form of *F. caryophyllacea*, growing rather robustly owing to overwatering and low light intensity. In describing *Gladiolus sparrmannii* in 1814, based on specimens collected in South Africa before 1770 by Anders Sparрман, Thunberg added yet another species of *Freesia*. Thus by the first quarter of the nineteenth century, five named species of *Freesia*



were known, probably representing four native species. Three of these were in cultivation. There was no suggestion at this time that they constituted a distinct separable genus. Ker-Gawler (1804, 1827) who made a great contribution to the understanding of Iridaceae in segregating several genera from both *Ixia* and *Gladiolus*, as then understood (including *Hesperantha*, *Geissorhiza*, *Sparaxis*, *Anomatheca* and *Tritonia*) remained uncertain how to treat the group. He assigned *Gladiolus refractus* to *Tritonia*, *Ixia caryophyllacea* to incertae near *Sparaxis* and *G. xanthospilus* with doubt to *Tritonia*.

The early nineteenth century collectors, Ecklon, Zeyher and Drège, added only modestly to the knowledge of *Freesia*, and sent back to Europe collections of several species including *F. sparrmannii*, *F. refracta*, copious material of *F. corymbosa* (under the ms. name *Freesia odorata* Eckl.) and *F. leichtlinii* (named incorrectly *Tritonia securigera*). Burchell, also active in South Africa at this period, collected the common *F. corymbosa* and, interestingly, the first known specimens of *F. andersoniae*, a species only to be described over 100 years later.

It was only in 1866 that *Freesia* was described as a distinct genus, when Klatt published a description of *Freesia*, attributing the name to Ecklon. This name had not previously been published, but presumably derived directly from the manuscript name on Ecklon's collections of *F. corymbosa*. Some confusion has existed over the similar name *Freesea* Ecklon, an invalid genus, published without description (Ecklon, 1827). It was apparently intended to accommodate a group of species previously included in *Tritonia*, none of which actually belong in *Freesia* as now circumscribed. Klatt admitted three species to *Freesia*, *F. refracta*, *F. xanthospila*, and *F. odorata*, the latter an illegitimate and superfluous name since *Gladiolus sparrmannii* was cited as a synonym, though Klatt presumably intended *F. odorata* to apply to what is currently called *F. corymbosa*. A few years later, in 1874, Klatt described *Freesia leichtlinii* from plants in cultivation in Europe. The discovery of this species is discussed in detail in the systematic treatment. *Freesia leichtlinii* rapidly became a favoured horticultural subject, and when *F. alba* was introduced in England in 1878, the genus became even more important in horticulture. Its horticultural history, dealt with in the following chapter, begins at this period.

*Freesia alba* was formally described first by G. L. Meyer as *F. refracta* var. *alba*, and it was widely known by this name although as Gumbleton (1896) pointed out, *F. refracta* is a very different species and that *F. alba* was quite distinct. Curiously Baker (1892, 1896) treated *Freesia* as monotypic, under the name *F. refracta*, but he did recognize several varieties.

After 1900 the study of *Freesia* shifts from Europe to South Africa where Louisa Bolus, very active in the field, promoted the study of many groups of Cape plants including *Freesia*. In the short space of eight years, from 1926

—1934, she and her student, W. F. Barker described nine species, of which five are still recognized (Table 1). The nomenclature and typification of the genus was then in great confusion which resulted in Bolus describing as new some species well known in Europe, and in the misapplication of several names. Nevertheless she had, by 1933 progressed sufficiently in her understanding of *Freesia* to provide a key to 11 species (Bolus, 1933) she then recognized. This tentative treatment is remarkably similar to my own conclusions presented in this revision, and summarized in Table 1.

Bolus' studies were complemented by Brown (1933) who corrected some of the nomenclatural errors in Bolus' work. In 1935 Brown produced his monograph of *Freesia*, in effect combining Bolus' field knowledge with his understanding of the work done on the genus in the eighteenth and nineteenth century. As already mentioned, Brown's work suffered by his failure to relate several species known only from cultivated plants in Europe to wild counterparts and he thus overestimated the number of species. No

TABLE 1.

Species of *Freesia* arranged in systematic order with general distribution ranges and habitats.

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Section <i>Viridibractea</i>	
<i>F. alba</i> (G. L. Meyer) Gumbleton	Southern Cape Coast, Plettenberg Bay to Hermanus—forest edges in sand.
<i>F. sparrmannii</i> (Thunb.) N.E.Br.	Langeberg foothills, forest edges.
<i>F. caryophyllacea</i> (Burm.f.) N.E.Br.	Caledon and Worcester east to Heidelberg—low bush on clay-shale soils.
<i>F. elimensis</i> L.Bol.	Heuningrug, S. of Bredasdorp—in fynbos on limestone.
<i>F. leichtlinii</i> Klatt	Southern Cape Coast, Agulhas to Mossel Bay—sandy soil in restioveld.
<i>F. fergusoniae</i> L.Bol.	Riversdale to Mossel Bay—low bush on heavy clay.
Section <i>Freesia</i>	
<i>F. refracta</i> (Jacq.) Klatt	Worcester district east in the southern Cape and Little Karoo—dry stony situations.
<i>F. corymbosa</i> (Burm. f.) N.E.Br.	Eastern Cape, Longkloof to East London—in low bush, sand or clay.
<i>F. occidentalis</i> L.Bol.	Bonteberg Karoo north to Calvinia—arid, stony habitats.
<i>F. speciosa</i> L.Bol.	Little Karoo—rare.
<i>F. andersoniae</i> L. Bol.	Upper Karoo, Northern Cape, Orange Free State—rocky hills.

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further species of *Freesia* have been described since Brown's work but extensive collecting by G. J. Lewis, W. F. Barker and others, myself included, has filled many gaps in the ranges of species. The present study thus aims to fully document the distribution of species of *Freesia*, as well as to try and correct the shortcomings in Brown's monograph. This includes both the relating of species described in Europe from cultivated plants to wild species, and the emendation where necessary of the nomenclature.

#### RELATIONSHIPS

*Freesia* is a member of subfamily Ixiodeae and it has the typical several internode, basal rooting corm, and spicate inflorescence of the group. The significant taxonomic features of the genus are its conical corm, with netted tunics, several equitant leaves, stem flexed below the inflorescence, secund flowers, deeply forked style branches and rough surfaced capsule with large seeds. It agrees in all these characters with *Anomatheca* Ker-Gawler (Lewis, 1954; Goldblatt, 1971, 1972) a genus placed by Baker in *Flora Capensis* as a subgenus of *Lapeirousia*.

*Freesia* and *Anomatheca* are in fact very closely allied, and separable only on minor differences in the flower structure. The flower of all species of *Freesia* has perianth tube divided into two parts, a slender basal portion which widens abruptly into a much wider and longer cylindrical upper part. In some species the tube is slightly curved in the throat. In *Anomatheca* the perianth tube is either narrow and cylindrical throughout (*A. laxa*, *A. juncea*) or it widens gradually from the base (*A. grandiflora*, *A. viridis*, *A. fistulosa*). *Freesia* and *Anomatheca* are identical cytologically, both having a diploid number of  $2n = 22$ , and similar karyotype of small chromosomes (Goldblatt, 1972).

The affinities of *Freesia* and *Anomatheca* are more difficult to assess. The netted corm tunics and divided style branches suggest a relationship with *Watsonia* and its allies, which also have divided style branches, but rather different corm tunics. In appearance the corms of *Freesia* and *Anomatheca* seem to have more in common with *Tritonia*, *Ixia* and *Sparaxis* and their relationship may perhaps lie in this direction. If so, the divided style branches must be less significant taxonomically, and presumably arose independently in these two genera. Further information on the relationships of genera of Ixiodeae may be obtained by studies in chemotaxonomy and molecular biology, but morphology, anatomy and cytology are unlikely to provide new insights into this question.

#### GEOGRAPHY

*Freesia* is endemic in southern Africa and is restricted almost entirely to the Cape Province of South Africa. Species are concentrated along the south



FIG. 1.

Geographic distribution of *Freesia*, with numbers indicating concentration of species in degree squares of latitude and longitude.

coast and adjacent interior valleys (Fig. 1) and all but *F. andersoniae* occur in an area of significant winter rainfall. *F. occidentalis* is the only winter rainfall area species with a western rather than southern Cape distribution, and it occurs from the Bonteborg Karoo north to Calvinia along the very dry eastern foothills of the Cedarberg and Swartruggens, and in the Doorn-Tanqua River basin.

*Freesia andersoniae*, which has as wide a range as all the winter rainfall area species together, occurs in the upper Karoo, Northern Cape, western Orange Free State, and reputedly, although there are no records, in the south-western Transvaal and southern Botswana. This area is a semi-arid steppe and grassland which has predominantly summer rainfall, but also some winter precipitation in the south.



## CYTOLOGY

The basic chromosome number in *Freesia* is  $x = 11$ . All but two of the 11 species have been counted at least once, and all reports so far are diploid,  $2n = 22$ . The first count in the genus was made by Taylor (1926) who counted  $2n = 22$  in a cultivar which he referred to *F. refracta* as cv "Fischer." Brittingham (1934) also found  $2n = 22$  in two cultivars "Rainbow Mixture" and "Purity" and  $2n = 44$  in a third, "S. & W. Improved Purity," these cited as varieties of *F. refracta*. Further counts were published in Darlington & Jana-ki Amal (1945) by Lawrence for *F. "hybrida"*,  $2n = 22, 33$  and  $44$ , and by LaCour for plants identified as *F. leichtlinii*,  $2n = 22$ . Further counts on cultivars were made by Mohr (1958) who reported nine named varieties to be polyploid,  $2n = 44$  and another three diploid,  $2n = 22$ .

The first published counts for plants of wild origin were reported by myself (Goldblatt, 1971) for *F. refracta*, *F. alba* (as *F. muiirii*), *F. caryophyllacea* (as *F. elimensis*) and *F. cf. speciosa*. The latter count must be discounted as plants did not flower and had to be discarded before determination could be confirmed. The first counts on wild plants were however probably made by Zeilinga (1970—ms) who counted *F. parva*, *F. andersoniae* and *F. refracta*, all reported as  $2n = 22$ . Unfortunately there are no records of localities for any of the plants counted, nor were vouchers made, so determinations cannot be verified. In all probability *F. parva* is what in this treatment is called *F. caryophyllacea*. There is no reason to doubt the identity of the plants reported as *F. refracta* and *F. andersoniae*. Zeilinga's counts are listed here in Table 2, which includes reports for wild species.

Further counts of  $2n = 22$  have been made for plants from horticultural sources and named *F. refracta* by Banerjee & Sharma (1971) and Banerji & Chaudhuri (1972). The identity of these plants is unknown, but they are almost certainly not *F. refracta*.

## EVOLUTION

Species of *Freesia* are clearly closely related, but within the genus a few evolutionary trends are apparent. The near actinomorphic flowers of *F. alba* are probably primitive compared to the more zygomorphic and bilabiate flowers of other species. The green herbaceous bracts of section *Viridibractea* also appear to constitute a less specialized character than the dry, scarious bracts found in *F. refracta*, and the peculiar dry, brown-tipped bracts in the other members of section *Freesia* are presumably a further specialization. The characters of bract and flower are correlated, for species of section *Viridibractea* have in general less modified flowers than section *Freesia* in which the three allied species, *F. refracta*, *F. corymbosa* and



TABLE 2.

Chromosome numbers in wild species of *Freesia*. All localities in the Cape Province, South Africa. Original counts are in bold type. Counts for material of horticultural origin are not listed.

Species	Diploid Number	Collection Data/Reference
Section <i>Viridibractea</i>		
<i>F. caryophyllacea</i>	<b>22</b>	N. of Stanford, <i>Goldblatt</i> 4846 (MO); Albertyn-Leeu R. road, Caledon distr. <i>Goldblatt</i> 4836 (MO).
	<b>22+1B</b>	roadside N. of Napier, <i>Goldblatt</i> 5598 (MO).
	<b>22</b>	Zeilinga (ms-1970, as <i>F. parva</i> , no collection data) <i>Goldblatt</i> (1971), as <i>F. elimensis</i> , Bredasdorp distr., <i>Goldblatt</i> 379 (BOL).
<i>F. alba</i>	<b>22</b>	near Riviersonderend, <i>Goldblatt</i> 3589 (MO).
	<b>22</b>	<i>Goldblatt</i> (1971), as <i>F. muiirii</i> , ex hort., <i>Goldblatt</i> 145 (J).
	<b>22+1B</b>	Sandbaai, near Hermanus, <i>Goldblatt</i> 5293 (MO).
<i>F. fergusoniae</i>	<b>22</b>	near Riversdale, <i>Goldblatt</i> 3742 (MO), <i>Goldblatt</i> 4893 (MO).
<i>F. leichtlinii</i>	<b>22</b>	Zoetmelksvlei, near Agulhas, <i>Goldblatt</i> 4864 (MO).
<i>F. sparrmannii</i>	<b>22</b>	Grootvadersbos, near Heidelberg, <i>Goldblatt</i> 4959 (MO).
Section <i>Freesia</i>		
<i>F. refracta</i>	<b>22</b>	near Stormsvlei, <i>Goldblatt</i> 3717 (MO); Muiskraal-Barrydale road, <i>Goldblatt</i> 3770 (MO).
	<b>22</b>	Zeilinga (ms-1970, no collection data); <i>Goldblatt</i> (1971), Worcester distr., <i>Goldblatt</i> 143 (J).
<i>F. occidentalis</i>	<b>22</b>	Agter Cedarberg, E. of Matjesrivier, <i>Goldblatt</i> 4069 (MO).
<i>F. corymbosa</i>	<b>22</b>	Upper Longkloof, <i>Goldblatt</i> 4949 (MO). Klein R., N. of Hankey, <i>Goldblatt</i> 4935 (MO).
<i>F. andersoniae</i>	<b>22</b>	Zeilinga (ms-1970, collection data unknown).

#### Uncounted species

*F. elimensis* (plants counted as *F. elimensis* have been redetermined as *F. caryophyllacea*).

*F. speciosa* (the count published for *F. cf. speciosa* (*Goldblatt*, 1971) must be disregarded as determination has not been confirmed).

*F. occidentalis*, have the most strongly bilabiate flowers, with, in addition, the inner tepals characteristically cordate lobed at the base.

On the above grounds it seems reasonable to regard section *Viridibractea* as the more primitive group, and within it the almost actinomorphic *F. alba* seems to be the least specialized species of all. Within the section, prostrate leaves, found in *F. caryophyllacea* and *F. fergusoniae*, are presumably derived, and these two are also unusual in their early blooming habit. Section *Freesia* comprises two groups, the small flowered *F. refracta* and its allies, mentioned above, with very specialized flowers, and *F. andersoniae* and *F. speciosa*, a related species pair with strikingly large flowers, structurally similar to but seemingly less specialized than those of the *F. refracta* group.

#### SPECIATION

The most significant factor in speciation in *Freesia* appears to be geographical isolation and this in fact seems to be the sole driving force for speciation in section *Freesia* while in section *Viridibractea* the situation is more complex. The three closely allied species of section *Freesia*, *F. corymbosa*, *F. refracta* and *F. occidentalis*, appear to have partitioned the dry interior valleys of the Cape Floristic Region and the adjacent western and southern Karoo (Fig. 2). In the west, *F. occidentalis* stretches from the Calvinia district south along the eastern Cedarberg, Swartuggens and Tanqua basin to Karooport and the Bonteberg Karoo. *F. refracta* extends from the adjacent Hex River Valley, and the Worcester Karoo east through the Little Karoo to the Oudtshoorn district, where the most easterly records are from the western valleys of the Kammanassie mountains. *F. corymbosa* continues this distribution, with its westernmost records in the foothills of the central and eastern Kammanassie mountains. This species extends through the Long Kloof as far east as the southern Transkei (Bawa Falls), being particularly common in the Port Elizabeth and Grahamstown areas. In spite of their adjacent ranges, these three species are quite distinct with no intermediates known. They probably evolved from a common ancestor the range of which became broken up during a drier period of the more recent past.

The remaining two species of the section, the large flowered *F. andersoniae* and *F. speciosa*, also appear to have had a common ancestry. *F. speciosa* is rare, and confined to a few sites in the western Little Karoo while *F. andersoniae*, more successful, is common in the upper Karoo and northern Cape, particularly at higher elevations, or where rainfall is more generous.

Speciation in section *Viridibractea* involves ecological and seasonal factors as well as geographical isolation (Fig. 3) and species are often adapted to contrasting habitats in the same general area. *F. alba* and *F. leichtlinii*

grow in sand along the southern Cape coasts, but *F. alba* is found mainly in stonier sites along forest margins, while *F. leichtlinii* grows in deep sand in restio veld. When growing near one another hybrids are found. *F. caryophyllacea* which extends from the Caledon and Worcester districts east to Heidelberg is restricted to clay and shale soils in low growing renosterbos type vegetation. Its habitat is thus distinct from the allied *F. alba* although they may grow nearby. Hybrids are suspected in intermediate situations. *F. elimensis* is confined to a limestone ridge near Bredasdorp. It appears to have originated through hybridization between *F. caryophyllacea* and *F. alba*, but today comprises a stable, uniform series of populations adapted to a limestone substrate.

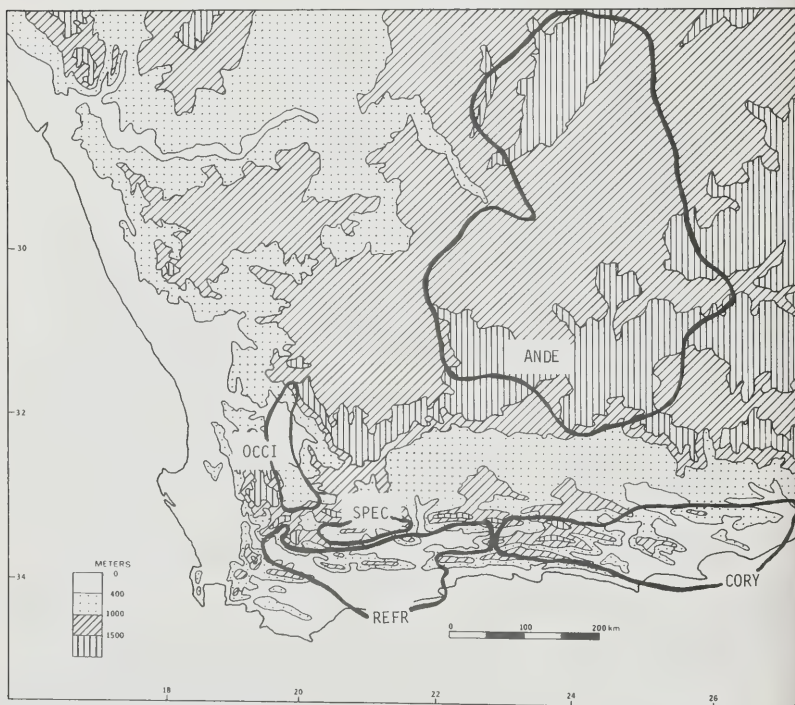


FIG. 2.  
Distribution of species of *Freesia* section *Freesia*.

Geographic isolation is the most likely cause of speciation for *F. sparrmannii*, a species allied to *F. alba*, which is adapted to sandy soils along forest margins. It is restricted to a small area of the Langeberg foothills, well inland from the coastal forest where *F. alba* occurs. *F. caryophyllacea* and *F. fergusoniae* also appear to be species with a common origin, but appear to have differentiated in isolation. Both grow in heavy clay soils in renosterbosveld but *F. fergusoniae* is found in the southern Cape from the Riversdale area eastward and *F. caryophyllacea* occurs west of Riversdale. Separation of flowering time reinforces their isolation since *F. caryophyllacea* blooms from April to June and *F. fergusoniae* from late June to August.

### HORTICULTURAL HISTORY

The horticultural history of *Freesia* is probably less well known than for most plants of comparable economic importance. The origin of the early cultivars has in fact been documented, though the literature is scattered.

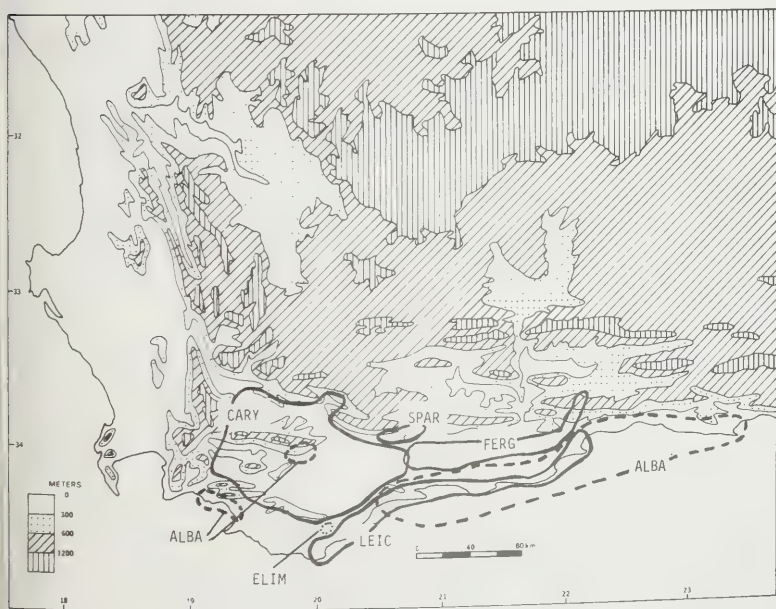


FIG. 3.  
Distribution of species of *Freesia* section *Viridibractea*.

Much that has been written seems confusing and contradictory owing to the frequent misapplication of specific names and to the vastly different taxonomic treatments of the genus that have been in use over the last one hundred and fifty years. The history as outlined by Chittenden (1951) in the *Royal Horticultural Society Dictionary*, by Morgan (1929, 1930), Brown (1935), Zeilinga (1970–ms), Goemans (1980) and others, varies in detail and accuracy. Thus it seems useful for me to again relate the history here, giving original sources wherever possible.

*Freesia* was first grown in Europe, according to available records, in Holland in the mid-eighteenth century. The type collections of both *F. caryophyllacea* and *F. corymbosa* were grown in Holland by Burman, who described these two species in 1766. *Freesia refracta* was grown in Vienna later in the century and it was figured in 1795. These species, however, have little to do with the horticultural history of the genus as they were most likely not grown widely, nor were they used in the breeding experiments of the later nineteenth century. *Freesia caryophyllacea* and *F. corymbosa* probably did not persist in cultivation, but *F. refracta* either continued to be grown, perhaps only by plant collectors or was reintroduced from time to time, and it was sporadically figured (e.g. Redouté, *Liliacées*, tab. 419. 1813; Edwards, *Bot. Reg.* 2: tab. 135. 1816) in the nineteenth century. *Freesia corymbosa* was illustrated in Loddiges *Botanical Cabinet* (v. 19, tab. 1820) in 1832, as *F. odorata*, and was very likely reintroduced at about this period.

The history of the modern *Freesia*, however, really begins with the discovery by the horticulturist and plant collector, Max Leichtlin, of yellow-flowered plants in the Botanic Gardens at Padua (Jacob, 1909). He obtained some specimens, grew them himself, and distributed material widely. Klatt described this *Freesia* as *F. leichtlinii* in 1874, and it was figured repeatedly in horticultural journals in the following decade. It was evidently a popular ornamental pot plant, and available in the nursery trade. How *F. leichtlinii* ever reached Padua will probably remain a mystery, but the species was evidently discovered in South Africa in the 1820s by Ecklon and by Drège and either of these collectors may have been responsible for its introduction into Europe.

The next introduction of importance was the white-flowered, sweet-scented plant called *Freesia refracta* var. *alba* which appeared in the English nursery trade in 1878. This is now called *F. alba*, and is known today to be native to the southern Cape Province. Wild plants most closely matching the introduction occur in the Knysna area of the south coast. Shortly after its appearance in England, *F. alba* spread to the Continent and then to North America, and it was figured in numerous horticultural publications in the following twenty odd years, generally as *F. refracta* var. *alba*.

There is no record of how *Freesia alba* reached England and it was prob-



ably a casual introduction. MacOwan (1888) hints in a brief note that this species may have been cultivated at the Cape by Ecklon in the 1820s and then have been grown there continuously. He also suggests that the pure white form was the result of deliberate selection over a sixty year period. Brown (1935: 25) doubted this strongly, and I concur for there is no evidence supporting this statement. Indeed, the lack of specimens of *F. alba* collected either by Ecklon or others during the early to mid-nineteenth century suggests MacOwan was wrong.

Breeding of *Freesia* began immediately after *F. alba* came on the market. Corms of *F. alba* together with *F. leichtlinii* were acquired in 1878 by Rodolfo Ragionieri, head gardener of the Marquis Corsi-Salviati, who lived near Florence. The plants flowered in the same year (Ragionieri, 1884) and were crossed to produce the hybrids later named *Freesia* "*Giardino Corsi-Salviati*".

There are few records of *Freesia* breeding until the introduction in 1897 of the rose-pink-coloured form of *F. corymbosa*, which was named *F. armstrongii*. However, some sort of selective breeding apparently took place, as evidenced by the introduction by Suttons of *F. leichtlinii* "*major*" sometime before 1896 (Gumbleton, 1896) and a few other named forms. Morgan (1929, 1930) gives an indication of *Freesia* growing in North America and mentions Richard Bagg who had been hybridizing *Freesia* since 1885, although this work seems to have been of little importance.

The rose-pink-flowered *Freesia* was the plant which really provided the stimulus to *Freesia* breeding. Watson (1898) records that plants were sent to Kew by a Mr. Armstrong, of Port Elizabeth, who found them growing wild on a farm near Humansdorp. A half-dozen specimens bloomed at Kew in 1898, when the plant was named *F. armstrongii*. Stocks were increased yearly, and a good display was recorded in 1901 in *The Garden* 59: 374. The hybrid known as *F. X kewensis* dates from this time, and it was, according to records, an unintended cross between *F. leichtlinii* and *F. "armstrongii"* that arose at Kew Gardens.

The Dutch nursery firm of Van Tubergen soon acquired *Freesia armstrongii*, and this, crossed with *F. alba*, yielded the rose-coloured-hybrid marketed in 1905 as *F. "tubergenii."* Van Tubergen continued breeding with the species and hybrids then available (Hoog, 1909), and produced a range of tall *Freesias* with colours ranging from blue, mauve, shades of rose, yellow and white. The son of Rodolfo Ragionieri, Attilio, also acquired *F. armstrongii* and bred a strain called *F. "ragionieri"* (Grignani, 1907) by crossing it first with *F. alba* and *F. leichtlinii*, and continuing to breed the offsprings of these hybrids.

In this early history of *Freesia*, mention must also be made of the so-called Chapman *Freesias*, raised by F. Herbert Chapman. According to

Jacob (1909), Chapman crossed *F. alba* (*F. refracta alba*) with a plant called *F. aurea*, and then crossed the resulting F1 hybrids back to *F. alba* to produce a range of deep to pale yellow, tall Freesias, the finest form of which became known as *F. "chapmanii."* *Freesia aurea* was a name used in horticulture only, and is evidently a deep yellow flowered form of *F. corymbosa* (Brown, 1935) known botanically at this time as *F. odorata*. Michael Foster, who knew the Freesias in cultivation in England well (Foster, 1888), mentions an *F. aurea* being similar to *F. refracta*, but with rich bright yellow flowers and less scarious bracts. This is supported by observations by Gumbelton (1896) who describes *F. aurea* as deep golden, late blooming and very like *F. refracta* in other respects. *Freesia aurea* is thus a second form of *F. corymbosa* to play a role in the history of cultivated *Freesia*; the first being "*F. armstrongii*." It was also the fourth wild genome that entered the gene pool of horticultural stocks.

The subsequent history of *Freesia* breeding does not involve the wild species and is a complex story of the introduction of new varieties, changes in fashion and the resulting succession of named plants finding favour.

The transfer of the Ragionieri *Freesia* stocks to C. Bruggemann in southern France is recorded by Grignan (1907) but this strain was evidently lost during World War I (Morgan, 1929; Zeilinga, 1970 ms). Van Tubergen and several other European and American breeders continued to produce new varieties, and the first polyploid "Buttercup" made its appearance in 1911. Today the majority of registered cultivars is polyploid (Mohr, 1958; Zeilinga, 1970 ms), with diploid strains important mainly in areas where plants are grown (Sparnaaij et al., 1968) every season from seed. The story of *Freesia* breeding after 1920 has recently been described in some detail by Goemans (1980), a *Freesia* breeder whose knowledge of the genus in cultivation is unparalleled. *Freesia* breeding is continuing today and varieties including double flowered types are being produced that bear less and less resemblance to the humble wild species.

#### TAXONOMIC CHARACTERS

*Rootstock*—the root stock is a tunicate corm of several internodes, generally conic in shape, which ranges in size from fairly small, ca. 10 mm at widest diameter in species growing in sandy soil (*F. alba*, *F. leichtlinii*, *F. sparrmannii*) with rather fine whitish tunic fibres, to 15–25 mm at widest diameter with coarser, pale to almost brown tunic fibres in species of shaley or rocky sites.

*Stems*—the flowering stalk may be characteristically branched (*F. refracta*, *F. corymbosa*, *F. occidentalis*, *F. sparrmannii*, *F. leichtlinii*, *F. alba*) or characteristically simple (*F. elimensis*, *F. caryophyllacea*, *F. andersoniae*).

*F. speciosa* and *F. fergusoniae* most often have a single secondary branch, but well grown plants may be very branched. The character is in general very variable.

The stem is smooth in section *Freesia*, but bears minute papillae in section *Viridibractea*. The papillae are rather sparse and often only present towards the base, but are well developed in *F. elimensis* and *F. caryophyllacea*, where they are dense and can almost be called a pubescence.

Stems are prostrate at base in *F. fergusoniae*; often entirely prostrate in *F. caryophyllacea*, prostrate to inclined in *F. elimensis* and sometimes inclined in *F. alba* and *F. leichtlinii*. This character is somewhat variable, and shaded plants are usually erect, even in species which characteristically have prostrate stems.

*Leaves*—the several leaves are arranged in a fan and vary in shape, apex and orientation. In *F. fergusoniae* and eastern forms of *F. caryophyllacea*, they are prostrate (Figs 6, 8), short, comparatively broad, and obtuse at apex. The western and typical form of *F. caryophyllacea* has prostrate leaves with acute apices. Leaves are long, acute, and either inclined or erect in *F. alba*, *F. leichtlinii* and *F. elimensis* and generally erect in *F. sparrmannii*. In section *Freesia* narrow erect and acute leaves predominate, but *F. speciosa* and *F. occidentalis* have obtuse, somewhat broader leaves.

*Bracts*—As Bolus (1933) and Brown (1935) first pointed out there are two very different bract types in *Freesia*, the herbaceous type of section *Viridibractea* in which the margins only, are transparent, and the dry scarious, transparent bracts of section *Freesia*. Within section *Freesia*, the bracts vary to some extent both in size, and in presence of dark brown tips. The characteristically short bracts of *F. corymbosa* have conspicuous dark apices, while those of *F. occidentalis*, *F. speciosa*, and *F. andersoniae* have comparatively smaller dark tips. The bracts of *F. refracta* are pale green during development and only become transparent and dry as the flowers begin to fade.

The outer bracts are always larger and usually slightly shorter than the inner which they enclose. The apices of the inner bracts are forked for a short distance.

*Flowers*—The flowers vary from almost actinomorphic (*F. alba*) (Fig. 4 A) to weakly or strongly bilabiate (Fig. 4 B–G) with larger upper tepal and small lower tepals, but the stamens are always unilateral with contiguous anthers and stigma curved to lie above and behind them. The perianth tube of *Freesia*, which distinguishes the genus from its ally *Anomatheca*, is cylindrical and narrow at base, enlarging abruptly into a much wider, also more or less cylindrical upper part. The tube is straight, except at the junction of basal and upper parts, where it is curved in a few species of section *Viridibractea* (e.g., *F. sparrmannii*) and in section *Freesia*, where this is most pronounced in the very long tubed *F. speciosa*.

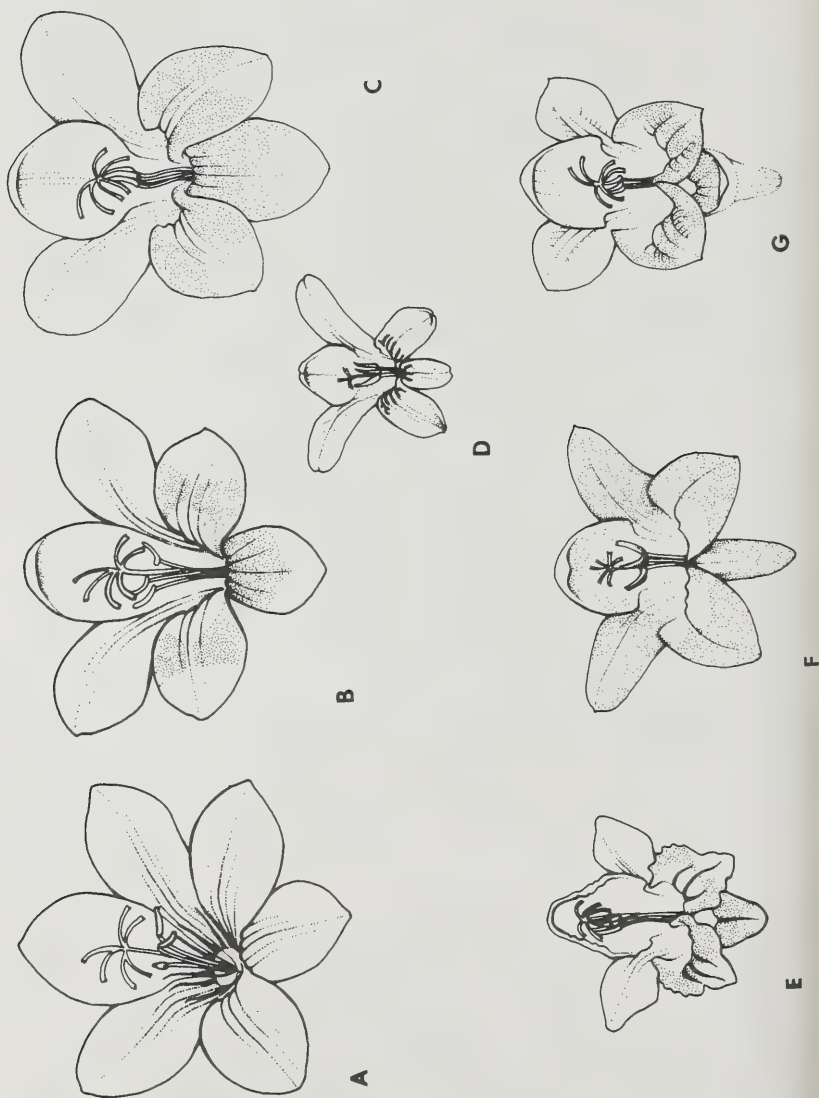


FIG. 4.

Flower types in *Freesia*: A. *F. alba*; B. *F. caryophyllacea*; C. *F. leichtlinii*; D. *F. sparrmannii*; E. *F. refracta*; F. *F. corymbosa*; G. *F. occidentalis* ( $\times 1,5$ ).

The tepals range from almost equal and outspread in *F. alba* (Fig. 4 A) to unequal and with a large erect or hood-like upper tepal and smaller lower tepals. In section *Freesia* the inner tepals are cordate at base (Fig. 4 E-G) more strongly so in *F. refracta*, *F. occidentalis* and *F. corymbosa* than in the other two species of the section.

There are no characters of taxonomic significance in the androecium and gynoecium. Size of these characters in general follows flower size. Anther length is a useful guide for flower size and is used in keys and as a diagnostic character.

**Fruits**—The developing capsules of *Freesia* species are characteristic in being covered with papillae which give the surface a rough, almost rugose appearance (Figs 9, 10). This is less pronounced in dry material or ripe capsules but still evident.

#### SYSTEMATIC TREATMENT

***Freesia* Klatt**, *Linnaea* **34**: 672. 1866 nom. cons. contra *Lomenia* Pourret; Baker, *Handbk. Irid.* 167, 1892 et *Flora Cap.* **6**: 98, 1896; L. Bolus, *S. African Gard.* **23**: 111, 1933; Brown, *Jl S. Afr. Bot.* **1**: 1–31, 1935.

*Tritonia* Ker, *Konig. & Sims Ann. Bot.* **1**: 227–228, 1804, et *Irid. Gen.* 113, 1827, pro parte.

Plant small to medium 50–500 mm high, deciduous. *Corms* small to medium, 7–25 mm in diameter, with tunics of fine to medium netted fibres. *Stem* erect, inclined or prostrate entirely or only in lower part, simple or branched, smooth or sparsely to heavily papillate, flexed horizontally below inflorescence (unless entirely prostrate). *Leaves* several, equitant, lanceolate to ensiform, acute to obtuse, erect, inclined or prostrate, soft to firm textured. *Inflorescence* a horizontal spike; *bracts* firm and green with a hyaline margin or dry and scarious, pale throughout or tipped dark brown; outer larger, enclosing inner, these being forked at apex. *Flowers* zygomorphic, with unilateral stamens, either with  $\pm$  equal, evenly disposed tepals (*F. alba*) or with unequal tepals and bilabiate flowers, usually strongly scented, and mostly shades of yellow and white, often purple-flushed, occasionally pink (forms of *F. corymbosa*); *tube* narrow, cylindrical at base, widening abruptly to larger cylindrical upper part; *tepals* subequal or upper larger and sometimes hooded, and lower three smallest, inner lobed and cordate at base in section *Viridibractea*. *Filaments* inserted at base of wide part of tepal tube, *anthers* oblong-linear unilateral, held opposite upper tepal. *Style* filiform, curving behind or over anthers, usually dividing near apex of anthers, branches slender, long, divided for half their length and arms



recurved. *Capsule* subglobose to oblong, three lobed, with rough, papillate surface, seeds several per locule, round and shiny. *Basic chromosome number*  $x = 11$ .

*Type species: Freesia refracta* (Jacq.) Klatt (lectotype).

Eleven species, all native in southern Africa, and all restricted to the winter rainfall area of the Cape Province except *F. andersoniae* which ranges throughout the Karoo, Northern Cape, western Orange Free State and extreme south-western Transvaal. Fig. 1.

#### SUBGENERIC CLASSIFICATION

Two sections are recognized as follows:

Section *Viridibractea* Goldbl., sect. nov.

*Folia* erecta, inclinata vel prostrata. *Caulis* parce vel dense papillosus. *Bracteae* virides, marginibus hyalinis. *Flores* subactinomorphes vel bilabiatai; *tepala* interiora basi non cordata.

*Leaves* erect, inclined or prostrate. *Stem* sparsely to heavily papillate. *Bracts* green with hyaline margin. *Flowers* with near actinomorphic tepals or bilabiate; *inner tepals* not cordate at base.

*Type species: Freesia alba* (G. L. Meyer) Gumbleton

Six species, restricted to the southern Cape Province, from Worcester and Houw Hoek in the west, south of the Langeberg-Outeniqua Mountain axis to Plettenberg Bay. Fig. 3.

#### Section *Freesia*

*Leaves* erect. *Stem* smooth throughout. *Bracts* pale greenish when young (*F. refracta*) or dry and membranous, usually dark brown-tipped. *Flowers* bilabiate, *inner tepals* cordate and weakly to strongly lobed at base.

Five species, ranging from Calvinia and Ceres in the west, to the border of the Transkei, and throughout the Karoo, Northern Cape to the western Free State and extreme south-western Transvaal. Fig. 2.

#### KEY TO *FREESIA*

1. Floral bracts membranous, transparent and dry (greenish in younger inflorescences, becoming papery from apex), with apices rust coloured in several species; inner (larger) tepals ovate or cordate and widest at base; stems smooth throughout.
2. Flowers normally 50–65 mm long.
  3. Leaves acute, tapering to apex, 5–10 mm wide; flowers cream to white with pale yellow markings; inner tepals 12–15 mm long and 8–9 mm wide; stamens 25–35 mm long ... 11. *F. andersoniae*

- 3'. Leaves obtuse (-subobtuse) apiculate, 10–20 mm wide; flowers yellow; inner tepals 13–18 mm long and 10–12 mm wide; stamens 32–40 mm long ..... 10. *F. speciosa*
- 2'. Flowers normally 25–40 mm long.
  - 4. Bracts rust-tipped, 3–7 mm long; flowers usually white and yellow (occasionally pink).
    - 5. Leaves tapering to apex, acute, usually much shorter than the stem; inner bract (bracteole) usually about 2 mm wide near apex, with apical divisions obtuse and dark brown ..... 9. *F. corymbosa*
    - 5'. Leaves obtuse (-subobtuse), two thirds to about as long as the stem; inner bracts about 1 mm wide near apex dividing into two narrow acute tips, barely tipped brown ..... 8. *F. occidentalis*
  - 4'. Bracts uniformly membranous and pale 5–8(–10) long; flowers pale, or more often dull green to purple, with bright orange markings on lower tepals ..... 7. *F. refracta*
- 1'. Floral bracts herbaceous, dark green, with a narrow hyaline margin; (not membranous even when aged); inner tepals oblong to broadly ovate and widest in lower third to midline, never cordate; stems either densely and minutely puberulent throughout, or at least sparsely puberulent-papillate towards the base.
  - 6. Lower part of perianth tube 12–15 mm long, about as long as upper part; upper tepal 5–7 mm wide; filaments 10–14 mm ..... 2. *F. sparrmannii*
  - 6'. Lower part of perianth tube usually 6–8 mm long, if longer, only about half as long as upper part; upper tepal 9–15 mm wide or more; filaments (10–)13–20 mm.
    - 7. Leaves obtuse, appressed to ground
      - 8. Flowers yellow with orange markings on lower three tepals, stem prostrate in lower part or entirely; flowering in July and August, Riverdale district and east to Mossel Bay ..... 6. *F. fergusoniae*
      - 8'. Flowers white or pale yellow with yellow markings in lower three tepals; stem usually entirely prostrate; flowering in May and June, Caledon, Worcester, Bredasdorp and Swellendam districts ..... 3. *F. caryophyllacea*
    - 7'. Leaves acute, prostrate, inclined or erect.
      - 9. Flowers cream to pale yellow with broad yellow markings on lower three tepals; flowering late August–September, coastal between Agulhas and Mossel Bay in sand ..... 5. *F. leichtlinii*
      - 9'. Flowers white to cream (often flushed lilac on reverse of tepals) with yellow marking on lower median or all three lower tepals or absent; flowering May–October, in various localities as below.
        - 10. Tepals subequal, nearly actinomorphic and all spreading; yellow marking on lower tepals absent or only on median tepal, coastal, between Hermanus and Plettenberg Bay ..... 1. *F. alba*
  - 10'. Tepals unequal, upper largest, erect or hooded over anthers, lower tepals smaller, horizontal.

11. Lower part of perianth tube 8–10 mm long, widening abruptly; lower tepal marking usually only on median tepal; restricted to limestone hills in the Bredasdorp district ..... 4. *F. elimensis*  
 11'. Lower part of perianth tube 6–8 mm long, widening gradually; usually all three lower tepals with yellow markings; widespread, mainly on clay soils, Caledon and Worcester, east to the Swellendam district ..... 3. *F. caryophyllacea*

## Section 1. VIRIDIBRACTEA

1. *Freesia alba* (G. L. Meyer) Gumbleton, Gard. Chron. ser. 3, 19: 392. 1896. Fig. 5.

*Freesia refracta* var. *alba* G. L. Meyer, Zeit. Schweiz. Gartenbauv. 1: 37. Feb. 1881; Baker, Handbk. Irid. 99. 1892 et Fl. Cap. 6: 167. 1896. Type: illustration in Zeit. Schweiz. Gartenbauv. 1, tab. 3.

*Freesia sparmanni* var. *alba* (G. L. Meyer) Phill. & N.E.Br., Fl. Pl. S. Africa 1: tab. 11. 1921.

*Freesia "alba"* Foster, Gard. Chron. ser. 3, 3: 588. 1888, nom. inval. auct. non approb.

*Freesia xanthospila* (DC in Red.) Klatt sensu Klatt, Ergänz. 10. 1882 (Abh. Naturf. Ges. Halle 15: 360. 1882) et in Dur. & Schinz, Consp. Fl. Africae 5: 188. 1895, pro parte, excl. type.

*Freesia refracta* sensu L. Bolus, S. African Gard. 23: 111–112. 1933.

*Freesia lactea* Fenzl ex N.E.Br., Jl S. Afr. Bot. 1: 23. 1935. nom. inval. sin. descr. lat.

See EXCLUDED SPECIES for discussion of *Freesia picta* N.E.Br. & *F. gentilis* N.E.Br., both probably based on cultivated, horticultural forms taxonomically closest to *F. alba*.

Plants (50–)120–400 mm high. *Corm* conic, ca 10 mm in diameter at base, with fine, light brown, reticulate tunics. *Leaves* linear-ensiform, usually erect, occasionally procumbent, tapering, acute, usually the longest about as long as the stem. *Stem* usually erect, rarely inclined, minutely papillate at least towards base, usually branched. *Spike* (2–)3–6(–8) flowered; bracts herbaceous, with hyaline margin, 5–8 mm long, inner usually slightly shorter. *Flower* (25–)35–45(–60) mm long, with a very strong, sweet scent, white, sometimes with purple lines in the throat, and often a purple flush on the reverse of the tepals, fading darker purple, with or without a yellow mark on the lowermost tepal; *tube* (15–)20–40 mm long, narrow basal part 6–12 mm; *tepals* subequal,  $\pm$  actinomorphic, outspread with upper tepal slightly larger and lower tepals slightly smaller, upper tepal 15–18 mm long, oblong to narrowly ovate, 8–12 mm wide. *Filaments* to 25 mm long; *anthers*

6–9 mm long. Style dividing at apex of anthers. Capsule ca 10 mm high and to 10 mm wide, rugulose. Chromosome number  $2n = 22$ .

Flowering time: late June–October.

Distribution: sandy soils, from Hermanus in the west to Plettenberg Bay; mainly along the coast, usually in light shade. Fig. 5.



FIG. 5.  
Morphology and distribution of *Freesia alba*: habit -  $\times \frac{1}{2}$ ; flower -  $\times$  life-size.

*Freesia alba* has been known and widely cultivated in Europe since 1881. It was evidently brought to England from the Cape sometime before 1878, in which year it was offered for sale by the New Plant and Bulb Co. of Colchester, being advertised as *Freesia refracta* "alba." The name was first used in horticultural literature, and the earliest use I have been able to trace (name only) is in the *Gardener's Chronicle*, also in 1878 (Vol. 10: 23). It apparently was something of a sensation for in the following few years it appeared in almost every horticultural journal of note both in Europe and North America (see Brown, 1935, p. 23-24 for references). The first valid description as *F. refracta* var. *alba* appears to have been published by G. L. Meyer in the rare journal *Zeitschrift des Schweizerischen Gartenbauvereins*, Vol. 1, dated February 15, 1881. It was described by W. Robinson, almost simultaneously, in *The Garden* (Vol. 19: 199) dated February 19, 1881.

Botanists appear to have been satisfied with this treatment of the pure white, richly scented form of *Freesia alba* then in cultivation, as a variety of the very different, and horticulturally unattractive *F. refracta*. Baker (1892, 1896), the major authority of the day, accepted this taxonomy, and in fact always treated *Freesia* as monotypic, with several varietal forms. Klatt (1882, 1895), however, did recognize *F. alba* as distinct, associating it with *Gladiolus xanthospilus* DC in Redouté, a species of uncertain identity, but most likely a poorly grown plant of *F. caryophyllacea* (Burm.f.) N.E.Br. This treatment, however, has received no support.

Michael Foster (1888) also provided what appears to be a different treatment, for in an article in *The Garden* dealing with the genus *Freesia* Foster uses the name *Freesia alba*. He described the plant in detail, as well as other named *Freesia* "types." However, he quite clearly stated that he did not believe these types to represent true species. Today we would consider Foster's named types as cultivars, and thus *F. alba* Foster has no taxonomic validity. Finally, Gumbleton (1896) in a note in *Gardener's Chronicle* clearly and unambiguously pointed out that *F. refracta* and *F. refracta* var. *alba* were quite separate species. He described and illustrated the major points of difference and raised the variety to specific rank as *F. alba*.

Today, the casual way in which Gumbleton essentially made this new combination would not be valid, there being no reference to authorities or literature citations. However, there is no ambiguity about his intention to establish *F. alba* at specific rank, nor in the identity of the species with which he was dealing, thus his combination *F. alba* (G. L. Meyer) Gumbleton seems acceptable. Gumbleton's note and combination have been overlooked by the systematic community, possibly due to ignorance of his work or more likely because Foster's invalid *F. alba*, intended as a horticultural name, was generally regarded as the first valid combination.

In South Africa where *Freesia* was studied in some detail by H. M. L.



Bolus (1927, 1933), *F. alba* (without authorities) was recognized as a distinct species, but owing to confusion over nomenclature and typification the name was used for *F. caryophyllacea* while the true *F. alba* was known as *F. refracta*. Brown (1935) partly cleared the confusion when he correctly typified *F. refracta*, but he used the name *F. lactea* Fenzl ex Klatt for *F. alba*. Brown's use of the name *F. lactea*, attributed to Klatt, is a puzzle. He cited the *Zeitschrift des Schweizerischen Gartenbauvereins* Vol. 1: 37, in which *F. refracta* Klatt var. *alba* is described in an article signed by G. L. Meyer. Here Meyer noted in passing that his variety was the same as a plant he had seen in the Botanical Gardens in Vienna, and bearing the name *F. lactea* Fenzl. I have been unable to trace any other use of the names *F. lactea* Klatt or Fenzl and thus regard Brown's *F. lactea* Fenzl ex Klatt as a new species dating from 1935, as *F. lactea* Fenzl ex N.E.Br. It is, however, invalid, as no Latin description or diagnosis was provided, as required by the *International Code of Botanical Nomenclature*, established in that year.

*Freesia alba* is easily recognized when live by its open, upright flowers, with subequal spreading tepals. The flowers are almost actinomorphic, except that the stamens are unilateral and the lower tepal sometimes has a yellow marking. Plants are generally quite tall, and erect with upright narrow leaves, but occasionally the leaves and stem may be inclined towards the ground. Flowers may be either pure white or with a pale purple flush on the outer tepals, a colour which intensifies on fading or dying.

The white form of *Freesia alba*, which matches fairly closely the type of *F. refracta* var. *alba*, grows wild along the southern Cape coast between George and Plettenberg Bay, apparently in rocky situations on the edge of coastal forest. Specimens with either pure white or lightly purple-flushed flowers have been collected at several sites along this stretch of coast, but all plants have fairly long tubed flowers. Further west along the coast plants have a shorter tube and often heavier purple markings. The species extends as far west as Hermanus where I have collected pure white-flowered plants with a short perianth tube (*Goldblatt* 5293).

There are also records of *F. alba* from inland, notably along the foot of the Riviersonderend Mts., and near Albertinia. *Freesia alba* is confined to sandstone derived soils, and usually grows in very stony situations, always where I have seen it, at the edge of, or in open forest.

*Freesia alba* is regarded as the most generalized and least specialized species of the genus because of its nearly regular flowers, green bracts and erect leaves. Its closest relatives are *F. sparrmannii*, a tiny flowered species of the Langeberg foothills, with hooded upper tepals, and *F. caryophyllacea*, which has large bilabiate flowers and typically prostrate leaves and stems. Hybridization and introgression between *F. alba* and *F. caryophyllacea* is suspected in the Riviersonderend area where plants intermediate between

the two species occur. *Freesia elimensis*, a limestone endemic from the hills S. of Bredasdorp, is also intermediate in many respects between *F. alba* and *F. caryophyllacea* and a hybrid origin is suspected for this species.

The name *Freesia muirii* has been applied to *F. alba* in some herbaria, but the type collections, made by Muir, near Mossel Bay, appear to represent *F. leichtlinii* and hybrids between this yellow-flowered species and *F. alba*. As discussed under EXCLUDED SPECIES, *F. muirii* is a name best rejected.

*Freesia alba* is probably the most commonly cultivated of *Freesia* species and although its flowers do not compare in size and colour with the many cultivars now available, it has by far the finest scent of all species and cultivars. Most, if not all, horticultural forms have *F. alba* in their pedigree and many even today bear a strong resemblance to it in the form of the flower. The superb scent however has been diluted or sometimes lost in some cultivars through breeding for other characters.

S. AFRICA, CAPE—3322 (Oudtshoorn): Wilderness, rock crevices (-DC), *Compton* 16973 (NBG); Wilderness, *Cassidy s.n.* (NBG 11095).

—3419 (Caledon): Kwaaiwater, Hermanus (-AC), *Williams* 251 (NBG); Sandbaai, Hermanus, coastal forest, *Goldblatt* 5293 (MO); Olifantskloof, N. of Riviersonderend (-BB), *Goldblatt* 3582 (MO); N. of Riviersonderend in shade near the river, *Goldblatt* 2053 (MO, NBG, S).

—3420 (Bredasdorp): Limestone hills 1.5 m W. of kloof on S. side of Potteberg (-BC), *Nordenstam* 1511 (S).

—3421 (Riversdale): 12 mi S. of Riversdale towards Blombos (-AA), *Lewis* 5629 (K, NBG); Zoetmelksfontein (-AB), *Muir* 383 (SAM); The Dunes, Riversdale distr. (-AC), *Ferguson s.n.* (BOL 18589, K); Stilbaai (-AD) *Rycroft* 3084 (NBG); Stilbaai-Blombos, *Thomas s.n.* (NBG 93847), *Wurts* 1556 (NBG); half mi E. of Albertinia (-BA), *Thomas s.n.* (NBG 93845); dwarf dune forest, The Fisheries (-BD), *Acocks* 21340 (K, M, PRE).

—3422 (Mossel Bay): Mossel Bay (-AA), *Rogers* 4416 (PRE), *Prior s.n.* (K), *Penther* 768 (K, PRE, Z); Goukamma, sandy soil (-BB), *Heineken* 119 (PRE), *Wurts* 2236 (NBG); Groenvlei-Wilderness, *Martin* 374 (BOL, NBG).

—3423 (Knysna): Brenton-on-Sea (-AA), *Denman* 31 (NBG); near Knysna, at Groot Rivier, coastal dunes, *Humbert* 10034 (P); Knysna Heads, rock ledges, *Keet* 1042 (GRA, P, PRE, SPE); Noetzi, *Middlemost s.n.* (NBG 61280, SAM 61716); stony ground, Plettenberg Bay (-AB), *Keet* 1021 (PRE, STE).

Without precise locality: Riversdale district, *Joubert s.n.* (STE 18575), *Muir* 4504, 4505 (K); Mossel Bay Division, *Muir* 4849 (K), 4849 B (K, PRE); Knysna-George, *Rodin* 1320 (BOL, K, MO, PRE); Knysna forests, *Laidley & Co.* 439 (G, K, Z); cult. Botanic Gardens, Cape Town, 2473 (PRE); *MacOwan* 2482 (K); hort. Reeves, Feb. 7, 1879 (K).

2. *Freesia sparrmannii* (Thunb.) N.E. Br., Fl. Pl. Africa 1: tab. 11. 1921; Brown, Jl S. Afr. Bot. 1: 19. 1935. Fig. 6.

*Gladiolus sparrmannii* Thunb., Kongl. Vetensk. Acad. Handl. 189–192.



FIG. 6.

Distribution and floral morphology of *Freesia sparrmannii*: flower -  $\times$  life-size.

1814. Type: S. Africa, Cape, exact locality unknown, *Sparrman s.n.* (S, lectotype and isotypes).

*Ixia sparrmannii* (Thunb.) Roem. & Schult., Mant. Syst. Veg. 1: 285. 1822.

*Meristostigma sparrmannii* (Thunb.) Steudel, Nomencl. Bot. 2: 130. 1840.

Plants 120–180 mm high. *Corm* conical, up to 11 mm in diameter, with tunics of fine, pale reticulate fibres. *Leaves* erect, linear-ensiform, acute, 100–160 mm long, the longest about as long as the stem apex. *Stem* usually straight, erect or inclined, 2–4 branched, sparsely papillate in lower half. *Spikes* horizontal, (3–)5–8 flowered; bracts (3–)4–7 mm long, herbaceous, with hyaline membranous margin; inner bract similar, often slightly shorter. *Flower* (30–)35–40 mm, not scented, white inside with yellow mark on lower tepal, and at apex of narrow part of tube, purple-flushed on reverse of upper

tepals and tube; *perianth tube* 20–27 mm, lower part 12–15 mm; *tepals* unequal, upper largest ca 11 mm long, 7 mm wide, obovate, slightly hooded, arching over anthers, upper laterals upright, ca 9 mm long, lower tepals to 9 mm long, 3–4 mm wide, flat. *Filaments* 10–14 mm long; *anthers* to 4.5 mm long. *Style* dividing 1–2 mm beyond anther apex. *Capsule* not known. *Chromosome number*  $2n = 22$ .

Flowering time: September.

Distribution: forest floor and margins, along the southern foothills of the Langeberg between Swellendam and Heidelberg. Fig. 6.

*Freesia sparrmannii* is a distinctive, low growing species, with a local distribution along forest margins and on the forest floor in the southern foothills of the Langeberg between Swellendam and Heidelberg. It appears to be closely related to *F. alba* but it is easily recognized because of the length of the narrow part of the perianth tube and generally small flowers with narrow tepals and perianth tube. Unlike *F. alba*, the flowers of *F. sparrmannii* are bilabiate, although this is not readily detected in dried material. The flowers are white inside and purple-flushed outside, with a small yellow mark in the lowermost tepal. On drying the purple colouring is intensified.

The species was collected in the 1770's by Anders Sparrman, and was subsequently described by Thunberg in 1814, who assigned it to *Gladiolus*. Klatt (1866) confused *G. sparrmannii* with *F. odorata* (i.e., *F. corymbosa*) and Baker (1896) included *F. sparrmannii* in *F. refracta* in *Flora Capensis*. It was only in 1921, when Phillips and Brown described *F. sparrmannii* var. *flava*, that this little known species regained recognition. Ironically, this variety, now *F. speciosa*, is no longer considered at all related to *F. sparrmannii*.

S. AFRICA, CAPE—3320 (Montagu): near Strawberry Hill Forest Reserve (Grootvadersbos) (-DD), *Esterhuysen* 10377 (BOL, K), *Goldblatt* 4959 (BR, C, E, K, MO, NBG, PRE, S, US, WAG), *Van der Merwe* s.n. (STE 10208).

—3420 (Bredasdorp): along the Buffeljags River (-BA), *Ecklon & Zeyher* 4027 (G, K, P).

Without precise locality: *Sparrman* s.n. (S).

3. ***Freesia caryophyllacea*** (Burm.f.) N.E.Br., Kew Bull. **1929**, 134 et Jl S. Afr. Bot. **1**: 12. 1935. Fig. 7.

*Ixia caryophyllacea* Burm.f., Fl. Cap. Prod. **1**. 1768. Type: S. Africa, Cape, original locality unknown (cult.) *Burman* s.n. (Herb. Burman, G. holotype).

*Antholyza caryophyllacea* (Burm.f.) Roem. & Schult., Syst. Veg. **1**: 448. 1817.

*Anisanthus caryophyllaceus* (Burm.f.) Klatt, Erganz. 10 (Abh. Naturf. Ges., Halle **15**: 344). 1882.



FIG. 7.

Morphology and distribution of *Freesia caryophyllacea*: habit -  $\times \frac{1}{2}$ ; flowers -  $\times$  life-size.

*Freesia parva* N.E.Br., Jl S. Afr. Bot. 1: 9. 1935. Type: S. Africa Cape, near Elim, Schlechter 7727 (K. lectotype, BOL, G, GRA, Z, isotypes).

*Freesia alba* Wats. sensu L. Bolus, S. African Gard. 23: 111-112. 1933.

Plants small, seldom reaching 100 mm high, usually  $\pm$  prostrate. *Corm* conic, 10-15 mm in diameter, tunics medium in texture, pale to light brown. *Leaves* oblong to lanceolate, acute or obtuse, up to 100 mm long, prostrate to inclined or  $\pm$  erect. *Stem* simple, rarely 1-branched, covered with a dense, minute puberulence, usually flexed close to ground level, and prostrate, occasionally (in shade) suberect or ascending. *Spike* usually prostrate or above ground level and horizontal or not flexed, 3-7 flowered; *bracts* green, herbaceous, usually with a hyaline margin, 4-8 mm long; inner bract similar, but usually smaller. *Flower* 30-45(-50) mm long, sweetly scented or odourless, white, often fading to brownish or purple, lined with purple within and



sometimes purple-flushed on reverse of tepals, marked yellow in midline of lower median tepal or all lower tepals; *tube* 20–25 mm, basal cylindrical part 6–8 mm; *tepals* unequal, 16–20 mm long, oblong to narrowly ovate, bilabiate, with upper tepal to 20 mm long, and 8–12 mm wide, hooded to erect and upper laterals reflexed outwards when fully open; lower tepals horizontal, smaller. *Filaments* 15 mm long; *anthers* 4–6 mm long. *Style* dividing at apex of anthers. *Capsule* 8–14 mm long, to 10 mm wide. *Chromosome number*  $2n = 22$ .

Flowering time: April–June.

Distribution: clay flats and slopes from the Caledon district extending east to Swellendam. Fig. 7.

*Freesia caryophyllacea* is a common although poorly known species of the Caledon, Bredasdorp and Swellendam districts where it typically grows on gravelly clay soils in renosterbosveld. It is remarkable in having a flowering period in the late autumn to early winter, a feature uncommon in the Iridaceae of the southern African winter rainfall area. Generally plants will come into bloom about a month after the first soaking rains of the season. If subsequent rainfall is scant, plants tend to be very dwarfed, and few flowered, but when well watered they may become robust with branched inflorescences held well above the ground.

The leaves of *F. caryophyllacea* are usually prostrate, less often ascending, but plants growing in the shade of bushes may develop fully erect leaves. Its stems are characteristically densely papillate-pubescent, a feature best developed in shorter stemmed individuals. The flowers are white, with yellow markings on the lowermost, or all three lower tepals, while the reverse of the tepals may be flushed with purple. In fading blooms or dried plants the purple flush is often accentuated, while the yellow markings may turn brown. When properly open the flowers are strongly zygomorphic. The upper tepal is largest, and is held erect or slightly forward and hooded over the anthers, while the upper laterals are reflexed outwards. The lower tepals form a nearly horizontal lip.

There is a confusing variation pattern in leaf shape and flower marking in this species. Populations in the west, centred around Caledon, have acute and often quite long leaves. This form matches the type specimen of *Freesia caryophyllacea*. The acute leafed plants usually have flowers with the yellow marking confined to the lowermost tepal only, and they also develop the darkest purple colouration on fading.

To the south-east, in the Bredasdorp area, and also to the north-east in the Robertson–Ashton area, plants have obtuse leaves, and flowers with yellow markings on all three lower tepals. Faded flowers often do not develop purple colouration. Such plants match exactly the type collection of *Freesia parva*.

There are intermediates in leaf shape, thus plants from Riviersonderend (*Stokoe s.n.*) and from the Stanford–Napier area (*Goldblatt 5598*) have sub-acute leaves. In such populations the younger, or smaller, plants often have fully obtuse leaves. Flower colouring varies inconsistently. Thus in some easterly populations such as at Mierkraal, south of Bredasdorp (*Goldblatt 5602*) flowers do develop purple with age, although surrounding populations do not.

The gradation in leaf shape from west to east, as well as the irregular pattern of variation in flower colouration, has convinced me that *Freesia parva* must be regarded as conspecific with *F. caryophyllacea*. Consequently *F. parva* is reduced to synonymy here.

Some of the variation in *Freesia caryophyllacea* may be due to gene flow between related species. *Freesia fergusoniae*, which has broad, obtuse, prostrate leaves and cream and orange flowers, is sympatric with *F. caryophyllacea* to the west of Heidelberg. The two have separate flowering times, *F. fergusoniae* typically blooming in July and August, but in some seasons both species may flower in late June—early July, which would make possible interspecific hybridization. If this occurred, subsequent introgression might explain the increasing obtuseness of leaves of *F. caryophyllacea* towards the east as well as the decrease in purple colouration in the flowers.

Hybridization probably also occurs between *Freesia caryophyllacea* and *F. alba* where these grow in proximity. Indeed, I believe *F. elimensis* to have had such a hybrid origin. Introgression between *F. caryophyllacea* X *alba* hybrids or between *F. caryophyllacea* X *elimensis* would explain the presence of deep purple flower colouring in *F. caryophyllacea* in areas where flowers usually lack purple, such as at Mierkraal (*Goldblatt 5602*).

*Freesia caryophyllacea* makes an inferior horticultural subject although it is of interest for its early blooming habit and the strong scent of some forms. Generally cultivated plants grow poorly. They either produce few flowers, if grown under good light conditions, or if grown in a greenhouse, or in poor lighting, become rank, leafy, and produce flowers which do not open properly or develop their normal form. A probable example of a greenhouse grown individual is the type illustration of *F. xanthospila*, figured in Redouté's *Liliacées*. This plant is probably *F. caryophyllacea* that has grown tall and leafy in a greenhouse in the dull, overcast winter of northern France (see EXCLUDED SPECIES) where it was grown.

S. AFRICA, CAPE—3319 (Worcester): Apiesklip, 11 m W. of Worcester on Olifantsberg (-CB), *Stayner s.n.* (NBG 77144); 7 km N. of Villiersdorp (-CC), *Goldblatt 5542* (K, MO, NBG, PRE); 30 km W. of Robertson, karroid bush (-DA), *Goldblatt 5632* (MO); Robertson (-DD), *Barker 7382* (NBG), *Schmidt 15* (PRE); 2 m from Robertson, *McMurtry s.n.* (NBG 92737).

—3320 (Montagu): 13.3 m E. of Bonnievale on N. bank of Breede River (-CC), *Perry 118* (NBG); Montagu common, *Hardy 252* (K).

—3419 (Caledon): Albertyn–Caledon, slopes above Leeu R. (-AA), *Goldblatt 4836* (MO); between Caledon and Baths (-AB), *Guthrie s.n.* (BOL 31510); near Caledon, *L. Bolus s.n.* (BOL 31511); Caledon, hill near Baths, *Marloth 14192* (PRE); road to Silverstream, S. Villiersdorp, *Goldblatt 1808* (MO); slope N. of Riviersonderend River, S. of Villiersdorp, *Goldblatt 4017* (MO); near Mission Station, 9 m from Caledon, *LeRoux 13* (STE); Hermanus district (-AC), *Taylor 3002* (NBG); Kleinmond road, near Caledon–Hermanus crossroads, *Goldblatt 3693A* (MO); Greyton–Riviersonderend (-B), *Middlemost 1684* (NBG); 10 m W. of Riviersonderend (BA), *Lewis 5911* (NBG); 5 m NW of Riviersonderend (-BB), *Heginbotham 14* (NBG); Riviersonderend, *Neethling s.n.* (BOL); 10 km N. of Stanford (-BC), *Goldblatt 4846* (MO); Caledon–Napier road, near Sandys Glen turnoff (-BD), *Goldblatt 5598* (MO); Fairfield, *Maytham-Kidd s.n.* (NBG 61286); Elim (-DA), *Schlechter 7727* (BOL, G, GRA, K, Z); Mierkraal flats, SW of Bredasdorp (-DB), *Goldblatt 5602* (MO).

—3420 (Bredasdorp): Wydgelegen (-AD), *Barker 4544* (NBG); Duiwenhoks River, Heidelberg (-BB), *Lewis 6133* (NBG); near Heidelberg, *Steyn 348* (NBG); between Swellendam and Heidelberg, *Goldblatt 1749* (MO, S, WAG); 18 km N. of Cape Infanta (-BC), *Goldblatt 5628* (MO); Bredasdorp (-CA), *Breach s.n.* (BOL 31514), *Goldblatt 5624* (MO); 8 km E. of Bredasdorp on Skipskop road, *Snijman 123* (NBG).

Without precise locality: Caledon Division, *Purcell s.n.* (SAM 66274); foot of Riviersonderend Mts., *Lewis 2321* (SAM); Riviersonderend Mts., *Hodge A146* (K); Swellendam Division, *Hurling & Neil s.n.* (BOL 20396); Ashton–Swellendam, *Barker 9268* (NBG).

4. *Freesia elimensis* L. Bolus, S. African Gard. **23**: 167–168. 1933; Brown. Jl S. Afr. Bot. **1**: 11. 1935. Type: S. Africa, Cape, 8 miles from Bredasdorp on Elim road, *Barker & L. Bolus s.n.* (Nat. Bot. Gard. 697/33 in BOL, lectotype and isotype).

Plants 60–150 mm tall. *Corm* conic, ca 10 mm in diameter, tunics of fine pale fibres. *Leaves* erect or ascending (rarely prostrate), sometimes exceeding the flowers, linear-lanceolate, usually acute. *Stem* inclined, minutely papillate, unbranched. *Spike* usually 4–7 flowered; bracts green, with hyaline margin 7–9 mm long. *Flower* 35–45 mm long, scented, white, flushed light purple on reverse of tepals, and with a yellow-orange mark on midline of lower tepal; *tube* 25–35 mm long, basal narrow part 8–10 mm long, widening very abruptly; *tepals* unequal, upper largest, 18–22 mm long, 10–12 mm wide, oblong, upper laterals slightly narrower, lower tepals 16–18 mm long, 8–9 mm wide, oblong, horizontal. *Filaments* 18–22 mm long, *anthers* 5–6 mm long. *Style* dividing at apex of anthers. *Capsule* and seed unknown. *Chromosome number*  $2n = 22$ .

Flowering time: mid May–June.

Distribution: apparently restricted to the Heuningrug, a limestone ridge S. of Bredasdorp. Fig. 3.

*Freesia elimensis* is closely related to *F. caryophyllacea*, and the two are difficult to distinguish. Generally, *F. elimensis* is more robust, has larger flowers of a blue-white colour, with a yellow mark only on the lowermost tepal. The stem of *F. elimensis* is also inclined rather than prostrate. The most important difference between the two species is in the perianth tube which is longer, 25–35 mm in *F. elimensis* with the basal part 8–10 mm, which widens very abruptly into a very broad upper part. In contrast the tube of *F. caryophyllacea* is 20–25 mm long, with the basal part 6–8 mm long, and the transition more gradual into the upper part.

In many ways *Freesia elimensis* seems intermediate between the prostrate, bilabiate flowered *F. caryophyllacea* and the erect, near actinomorphic flowered *F. alba*, and it may have had a hybrid origin. As far as is known, it is restricted to rocky limestone slopes, where it grows in sandy soil (Bolus, 1933). It has only been collected on the Heuningrug, a limestone ridge south of Bredasdorp.

S. AFRICA. CAPE—3419 (Caledon): The Poort, S. Bredasdorp (DB), Barker 4569 (BOL, NGB); 8 m from Bredasdorp on Elim road, Barker & L. Bolus s.n. (Nat. Bot. Gard. 697/33 in BOL), Lewis 5966 (NGB); Heuningrug, north slope near Mierkraal, Goldblatt 5618 (MO).

5. *Freesia leichtlinii* Klatt, Regal Gartenflora **289**: tab: 808. 1894. Type: illustration in Gartenflora **289**: 808. Fig. 8.

*Freesia xanthospila* (DC in Red.) Klatt var. *leichtlinii* (Klatt) N.E.Br., JI S. Afr. Bot. **1**: 22. 1935.

*Freesia muii* N.E.Br., Gard. Chron. ser. 3, **92**: 467. 1932; in part (nom. rej.) (see EXCLUDED SPECIES).

*Freesia middlemostii* Barker, S. African Gard. **23**: 112. 1933. Type: S. Africa, Cape, Bredasdorp, Middlemost s.n. (Nat. Bot. Gard. 1551/31 in BOL, holotype).

Plants 80–200 mm (–500 mm under bushes) tall. *Corm* small, conic 8–10 mm in diameter with tunics of fine, pale reticulate fibres. *Leaves* erect, or inclined (rarely prostrate), usually slightly shorter than the stem apex, but occasionally exceeding the stem (in shade), linear-lanceolate, seldom exceeding 8 mm in width, tapering, acute. *Stem* ± erect, or inclined, sparsely papillate in lower part, often simple or 1–2 branched. *Spike* 2–8 flowered; *bracts* green, with hyaline margin, 4–7 mm long, inner narrower. *Flower* (25–)30–40 mm long, strongly scented, cream to pale yellow, with lower tepals dark yellow-orange, and upper tepals often brown-purple-flushed on reverse, bilabiate with lower tepals horizontal to down curved; *tube* (15–)20–25 cm long, basal narrow part (4–)6–8 mm, bent at apex of narrow part;

*tepals* unequal, upper largest 14–18 mm long and 13 mm wide,  $\pm$  hooded, broadly elliptical, upper laterals ca 8 mm wide, lower laterals to 14–15 mm long, and 9–11 mm wide, ovate, margins curved upward. *Filaments* 10–14 mm long; *anthers* 6–7 mm long. *Style* dividing at apex of anthers. *Capsule* unknown. *Chromosome number*  $2n = 22$ .

Flowering time: August–September.

Distribution: southern Cape between the Mossel Bay district and Cape Agulhas, always near the coast, in sandy soil, with Restionaceae. Fig. 8.

*Freesia leichtlinii* is an attractive species with bilabiate pale yellow flowers, and bright yellow markings on the three lower tepals. The upper tepal



FIG. 8.

Morphology and distribution of *Freesia leichtlinii*: habit -  $\times \frac{1}{2}$ ; flower -  $\times$  life-size.



is distinctly hooded over the anthers and the upper laterals barely reflexed. The reverse of the tepals and tube are often lightly flushed with purple which intensifies in fading flowers or dried material. The plants are erect and generally rather slender, and often quite short. The leaves are usually upright but may be bent to one side, or rarely even prostrate. It grows in open areas among reed-like Restionaceae, e.g., *Chondropetalum* spp., in deep sand. The very small corms are often eaten by moles, that can destroy many plants in a population. Survival is ensured by the production of a small cormlet in many of the leaf axils. This character is known in other species of *Freesia*, but is best developed in *F. fergusoniae* and in *F. alba*, which also grows in sandy soils.

This species, first described by F. W. Klatt, has a curious history. Plants were apparently found by the horticulturist and plant collector Max Leichtlin in a neglected part of the Botanical Gardens in Padua in 1872. He took material back to England and after increasing stocks, he made plants available for cultivation. The plants described by Klatt thus came to him from Max Leichtlin's garden. *Freesia leichtlinii* remained in cultivation in Europe for some time, and was used in the production of new cultivars. The species was not known in South Africa at all, and when wild plants were discovered, first by Muir, and then by Middlemost, they were described as new, and in both cases named in honor of the collectors. There seems little doubt that *F. leichtlinii* is in fact the earliest name for the species. Although the cultivated plants from Leichtlin's garden seem more robust and broader leafed than wild plants, the flowers are identical in colour and form. The species is no longer in cultivation, presumably having been replaced by superior horticultural varieties.

It is quite unknown how *Freesia leichtlinii* came to be cultivated at Padua in Italy, but the species was apparently first collected in the 1820's in South Africa by Ecklon and by Drège. Ecklon's specimens came from the Bredasdorp district, and a sheet at Stockholm indicates the plants were sent by H. Joubert from Zoetendalvalley (sic). This collection bears the manuscript name *Sparaxis joubertii*. Drège's plants were evidently collected in the Tradouw ("Trado") area at 1 500–2 000 feet. There are no recent collections from this area, which is in the Langeberg Mts., and the locality may be mistaken. The early collections of this species were sometimes named *F. odorata* (= *F. corymbosa*) and it seems likely that *F. leichtlinii* was confused with this yellow flowered but otherwise very different species.

S. AFRICA, CAPE—3420 (Bredasdorp): The Poort, S. Bredasdorp (-CA). *Barker* 2691 (NBG), *Esterhuysen* 2184 (BOL). *Compton* 9011 (BOL, NBG); 8 mi. from Bredasdorp on Elim road, *Dymond s.n.* (Nat. Bot. Gard. 1858/33 in BOL); rietheuvels on farm Nacht Wacht, *Smith* 3045 (PRE); Agulhas (-CC), *Loubser* 2017 (NBG); 1 mi E. Cape Agulhas, *Nordenstam* 1431 (S); Agulhas-Struisbaai, *Salter*

4819 (BM, BOL, K); sandy flats E. Zoetendalsvlei, *Goldblatt 4864* (K, MO, NBG, PRE, WAG); "Zoetendalsvalley" *Ecklon s.n.* (S); S. Mungo Bay, Cape Agulhas, *Garside 4683* (K); sandy flats, Potteberg (-BC), *Esterhuysen 23226* (BOL). —3423 (Mossel Bay): dunes W. of Little Brak River, near railway bridge (-AA), *Thomas s.n.* (NBG 93846); Mossel Bay, *Prior s.n.* (K, Z).

Without precise locality: *Drège s.n.* "*Tritonia securigera*" (MO); "Trado, huge-lin", *Drège s.n.* (S); Bredasdorp distr. *Middlemost s.n.* (Nat. Bot. Gard. 609/31 in K), *Bishop Lavis s.n.* (BOL 21396); Mossel Bay Division, *Muir 4849* (K); hort. *Leichtlin* (1873) (K); hort. *Ware* (6/77) (K); herb. *Klatt* (S).

6. *Freesia fergusoniae* L. Bol., S. Afr. Gard. 17: 337. 1927. Type: S. Africa, Cape, near Riversdale, *Ferguson s.n.* (Nat. Bot. Gard. 423/27 in BOL, holotype); Brown, JI S. Afr. Bot. 1: 9. 1935. **Fig. 9.**

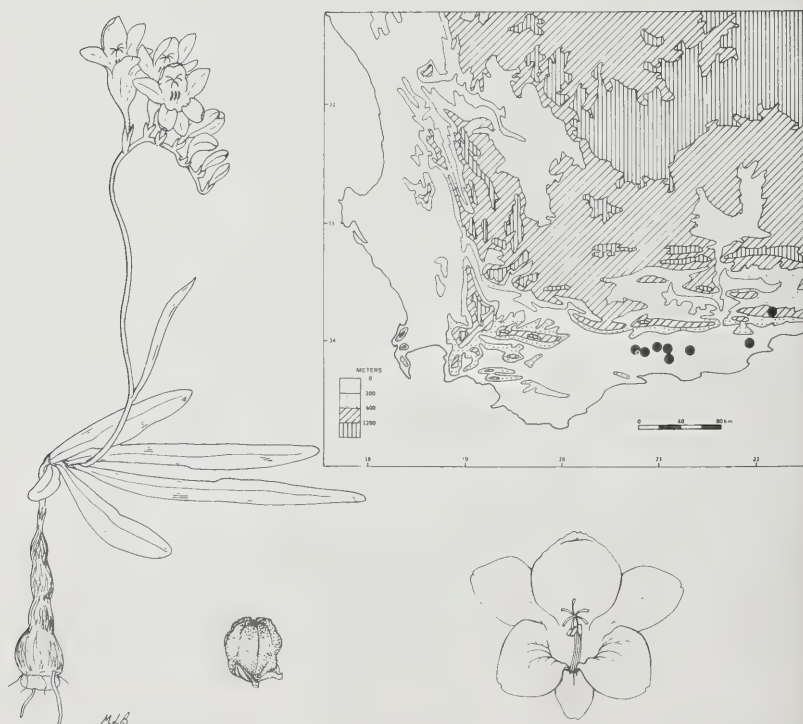


FIG. 9.

Morphology and distribution of *Freesia fergusoniae*: habit -  $\times \frac{1}{2}$ ; flower and capsule -  $\times$  life-size.

Plants (60-)100–200 mm high. *Corm* conic, to 15 mm in diameter, with pale medium to coarse reticulate tunics. *Leaves* prostrate, oblong, 100–150 mm long, outer, or all obtuse to subobtuse, acuminate, to 15 mm at widest. *Stem* prostrate entirely or only in lower part, and erect, to inclined in upper part, minutely scabrid-puberulent throughout or in lower part; usually 1–2 branched. *Spike* horizontal, 5–10 flowered, bracts herbaceous with hyaline margin, ca 6 mm long, inner similar but smaller. *Flower* 35–45 mm long, sweet-scented, cream-yellow, with dark yellow to orange markings on the lower three tepals, strongly-bilabiate; *tube* 22–26 mm long, slightly curved, narrow basal part 6–8 mm; *tepals* unequal, with upper largest, 12–14 mm long, oval, to 12 mm wide, erect to slightly hooded, outer whorl smallest, to 10 mm long and 8 mm wide, lower tepals  $\pm$  horizontal, and surface of lower laterals naviculate. *Filaments* 13–16 mm long; *anthers* 5–7 mm long. *Style* dividing just above apex of anthers. *Capsule* 10–12 mm long, ovoid, to 9 mm wide, rugulose. *Chromosome number*  $2n = 22$ .

Flowering time: (late June–) July–August.

Distribution: clay flats in renosterbosveld; common between Heidelberg and Riversdale and extending east to Robinsons Pass. Fig. 9.

*Freesia fergusoniae* is one of the more attractive species of the genus. Well grown individuals can reach 200 mm in height and may bear one or two branches, each carrying several flowers. The flowers themselves are large, creamy-yellow with deep yellow or almost orange markings on all three lower tepals. In the populations I have seen plants have a typical *Freesia* scent, which though unmistakable is far weaker than in *F. alba*. In seasons with scant rainfall *F. fergusoniae* blooms earlier than usual, late June or July, rather than August, and plants are stunted, only 60–80 mm high and unbranched.

This species is usually easy to distinguish from the other members of the genus with green bracts, and is recognized by its fairly broad, obtuse and prostrate leaves, prostrate lower part of the stem, and the deep yellow markings on all three lower tepals of the bilabiate flowers. Its closest relative is the autumn–early winter blooming *F. caryophyllacea* which has prostrate stems as well as leaves. The eastern forms of *F. caryophyllacea* have obtuse leaves and cream-white flowers with yellow markings and are sometimes difficult to distinguish from dwarf forms of *F. fergusoniae*. In such cases flower colour is the most useful character for separation, *F. fergusoniae* having darker yellow tepal markings.

*Freesia fergusoniae* is a common geophyte on the clay hills and slopes around Riversdale in the southern Cape, where it grows in renosterbosveld. It extends west to Heidelberg, where it overlaps with *F. caryophyllacea*, and east towards Mossel Bay and Robinsons Pass. Plants bloom best in cleared

or burned areas, and not at all in dense bush. It was not known until the 1920's when it was sent by Mrs. Ferguson, a native of Riversdale, to Louisa Bolus who subsequently described it. *Freesia fergusoniae* has not been introduced into horticulture, but is grown at the National Botanic Gardens at Kirstenbosch. It makes a good garden plant, easy to grow, and prolific in flowering.

S. AFRICA, CAPE—3322 (Oudtshoorn): Moeras R., N. end of Robinsons Pass (-CC), *Hops* 24 (BOL).

—3420 (Bredasdorp): Swellendam-Heidelberg (-B), *Van Niekerk* 443 (BOL).

—3421 (Riversdale): Riversdale (-AA), *Muir* 5570 (PRE); *Ferguson s.n.* (BOL 18652); hill slopes above Riversdale, *Lewis* 6006 (NBG); 5 mi S. Riversdale, *Lewis* 6189 (NBG); roadside W. of Riversdale, *Goldblatt* 3742 (C, MO, PRE, S, WAG), 4893 (MO), 5191A (MO); 13 m E. Heidelberg, *Barker* 10638 (NBG); Soetmelksrivier (-AB), *Lewis* 6190 (NBG); 5 mi N. National road, towards Herbertsdale (-BB), *Thomas s.n.* (NBG 93844).

Without precise locality: Riversdale hills, *Muir* 4352, 4429, 4430 (K); Riversdale Division, *Bartlett s.n.* (BOL), *Ferguson s.n.* (BOL).

## Section 2. FREESIA

7. *Freesia refracta* (Jacq.) Klatt, *Linnaea* **34**: 673. 1866; Baker, *Fl. Cap.* **6**: 98. 1896, excluding vars; Brown, *Jl S. Afr. Bot.* **1**: 17. 1935. **Fig. 10.**

*Gladiolus refractus* Jacq., *Ic. Pl. Rar.* **2**: tab. 241. 1795. Type; S. Africa, Cape, without locality, illustration in Jacq. *Ic. Pl. Rar.* **2**: tab. 241.

*Tritonia refracta* (Jacq.) Ker, König & Sims *Ann. Bot.* **1**: 228. 1804.

*Gladiolus resupinatus* Pers., *Syn* **1**: 45. 1805, nom superfl. pro *G. refractus* Jacq.

*Freesia hurlingii* L. Bolus, *S. African Gard.* **23**: 112. 1933. Type: S. Africa, Cape near Bonnievale, *Hurling & Neil s.n.* (Nat. Bot. Gard. 609/31 in BOL, lectotype, K, isotype).

Plants (80-)200-450 mm high. *Corm* conic, 15-20 mm in diameter, tunics pale, fine, reticulate. *Leaves* linear, tapering above, acute, 150-300 mm (or more) long, usually about two-thirds the length of the stem, but sometimes longer than the stem, 5-8(-10) mm wide. *Stem* smooth, erect, usually branched. *Spikes* horizontal to decumbent, 5-10(-12) flowered; *bracts* rather membranous, greenish in young stages, becoming dry and transparent, with brown veins, 5-8(-10) mm long, inner smaller. *Flowers* 25-35(-40) mm long, with a strong spicy scent, bilabiate, usually dull yellowish-brown or green to purple, occasionally pale yellow, with bright orange markings on lower tepals and purple veins in the throat; *tube* 16-24 mm, narrow basal part 5-9 mm; *tepals* unequal, inner cordate, upper largest, 11-14 mm long, 8-11 mm wide at base, hooded, upper laterals oblong, acute, 5-7 mm wide, 12-14 mm long, spreading, lower laterals hori-



FIG. 10.  
Morphology and distribution of *Freesia refracta*: habit and corm -  $\times \frac{1}{2}$ ; flowers and capsule -  $\times$  life-size.



zontal to downcurved, (8-)11 mm long, 7-9 mm wide, margins curved upwards, obscuring the lowermost tepal. *Filaments* 10-14 mm long; anthers 5-6 mm long. *Style* branching at apex of anthers. *Capsule* to 10 mm long, ca 10 mm in diameter, three lobed, sometimes more or less smooth, or rugulose. *Chromosome number*  $2n = 22$ .

Flowering time: (late June-) July-September.

Distribution: clay soil, mainly arid stony places, or in limestone, in the southern Cape between Gouritz Mouth and Stormsvlei, extending west to Worcester and the Hex River Valley, and local in the Little Karoo. Fig. 10.

*Freesia refracta* was one of the early species of the genus to become known to botany, having been described in 1795 by Jacquin, as a *Gladiolus*. The nomenclatural history of this species gives a clear idea of the confusion that *Freesia* caused plant systematists of the day. Thus *F. refracta* was transferred to *Tritonia* by Ker (1804) then renamed in *Gladiolus* by Persoon, before being finally placed in his new genus *Freesia* by Klatt.

Although *Freesia refracta* is typified by an excellent painting in Jacquin's *Icones Plantarum Rariorum* which is true in colour and form, and shows clearly a medianly zygomorphic bilabiate flower, the species became confused with the horticulturally popular *F. alba* (then *F. refracta* var. *alba*). This typically pure white species has upright, almost actinomorphic flowers, with the characteristic *Freesia* scent. Thus references to *F. refracta* in botanical and horticultural literature throughout the later nineteenth century may be for *F. alba* and this is still true today of some horticultural literature. This was undoubtedly the reason for H. M. L. Bolus describing *F. hurlingii* in 1933. At this time she was still calling *F. alba*, *F. refracta* (Bolus, 1933), incidentally calling *F. caryophyllacea*, *F. alba*. The confusion was only partly clarified by Brown (1935) where he calls the pure white form of *F. alba*, *F. lactea* (a nomen nudum).

*Freesia refracta*, native to the Worcester and Little Karoo, and southern Cape, is closely related to *F. occidentalis*, which occurs to the north; and to *F. corymbosa* which ranges from the eastern end of the Little Karoo through the Long Kloof into the eastern Cape. All three species have similar bilabiate flowers with small naviculate lower tepals and dry bracts. Apart from its usually dull brownish or greenish flowers, and heavy spicy scent, *F. refracta* can be distinguished from these by its entirely pale, membranous bracts. Both *F. occidentalis* and *F. corymbosa* have dark brown-tipped bracts as well as typically white and clear yellow flowers. *Freesia refracta* grows on shaley soils, generally in dry situations and often under shrubs and low bushes. It also occurs on limestone.

A collection from the Warmwaterberg, Little Karoo (*Boucher 1569*) represents an interesting variant. While the flowers are typical, the leaves are unusually short and broad, being less than half the length of the stem and up to 15 mm wide. Another unusual form was found by Lewis (4432) near the Kammanassie dam, which also has short leaves, but the margins and major veins are thickened and hyaline, and the apices almost pungent.

S. AFRICA, CAPE—3319 (Worcester): Osplaats Station, N.E. De Doorns (-BC), *Mauve & Oliver 226* (STE, PRE); between Osplaats and Tunnel sidings, *Rogers 16739* (K, Z); Worcester, Karoo Garden (-CB), *Olivier 51* (STE), *Compton 20521* (NBG), *Barker 4663, 8024* (NBG), *Hall s.n.* (NBG 20,007, STE), *Stayner s.n.* (NBG 87597, STE); 1 m W. Breede R. bridge, towards Rawsonville, *Lewis 6048* (K, NBG); near Robertson (-DD), *Barker 5391* (K, NBG, STE); Robertson-McGregor, *Van Breda & Joubert 1964* (PRE); Vrolikheid, McGregor, *Jooste 179* (STE), *Van der Merwe 2981* (K, PRE); 34 km E. Worcester, *Nordenstam & Lundgren 1148* (MO, S). —3320 (Montagu): Ashton (-CC), *Van der Spuy s.n.* (BOL); Bonnievale, *Hurling & Neil s.n.* (Nat. Bot. Gard. 609/31 in BOL, K), (BOL 20186, K); sub Marloth 11939, 11946 (PRE); near Bonnievale, *Loubser 2118* (NBG); Scheepersrust, E. Montagu (-CD), *Barker 5428* (STE); Op-de-Tradouw, W. Barrydale, *Goldblatt 2841* (MO); E. foothills of Warmwaterberg (-DC), *Boucher 1569* (STE); near Barrydale, on Montagu road, *Van Niekerk 577* (BOL).

—3321 (Ladismith): 14.8 m S.S.E. Ladismith (-CB), *Acocks 20575* (K, PRE); Muiskraal-Brandrivier (-CC), *Goldblatt 3770* (MO); Calitzdorp (-DA), *Blackburn s.n.* (BOL).

—3322 (Oudtshoorn): DeRust (BC), *Van Niekerk 482* (BOL); near Oudtshoorn (-CA), *Loubser 999* (NBG); hills near Kammanassie Dam (-CB), *Lewis 4432* (SAM); farm Die Krans, DeRust distr., *Dahlstrand 2414* (PRE); Oudtshoorn-deRust, *Van Niekerk 342* (PRE); Ruitersbos, stony hilltop (-CC), *Van Niekerk 75* (BOL, PRE).

—3420 (Bredasdorp): roadside near Stormsvlei (-AA), *Goldblatt 3717* (C, BR, MO, S, WAG, US); Kathoek (-AD), *Acocks 22285* (PRE); 11 m S. Buffeljachtsrivier (-BA), *Acocks 24041* (K, PRE, STE); Suurbraak, *Mauve 4781* (PRE), *Acocks 16088* (BM, K, PRE, S); Duiwenhoks rivier, between Vermaaklikheid and Port Beaufort (-BD), *Lewis 5976* (NBG, STE).

—3421 (Riversdale): Riversdale distr. (-A), *Ferguson s.n.* (BOL 31506, BM, K); Riversdale (-AA), *Muir s.n.* (PRE); hills near Riversdale, *Muir 4432* (K); near Riversdale, *Bayliss 6565* (K, MO, WAG), 5851 (MO); limestone hills near Stilbaai (-AD), *Goldblatt 4152* (MO); The Fisheries (-BD), *Acocks 21356* (K, NBG, PRE); Gouritz R. mouth, *Mauve 4758* (K, STE); 8 m. from Gouritz Mouth, limestone hills, *Thomas s.n.* (NBG).

8. *Freesia occidentalis* L. Bolus, S. African Gard. **23**: 266. 1933; Brown, JI S. Afr. Bot. **1**: 10. 1935. Type: S. Africa, Cape, Nieuwefontein, N.W. of Bitterfontein, said to have been collected at Nieuwefontein, but probably from the Bonteberg, *Compton 4273* (Bol. lectotype: K, isotype).

Fig. 11.

*Freesia framesii* L. Bolus, S. African Gard. **24**: 245. 1934. Type: S. Africa, Cape, Calvinia distr. (cult. Cape Town), *Ross Frames s.n.* (BOL 21366).

Plants 90–250(–500) mm tall. *Corm* conic, 13–20 mm wide at base, tunics of brown, medium to coarse fibres. *Leaves* erect, to 150 mm long, usually about two-thirds the length of the stem, 6–13 mm wide, usually obtuse to subobtuse, apiculate, (rarely sub-acute). *Stem* erect, usually branched, smooth. *Spikes* horizontal to slightly decumbent, (3–)6–10 flowered; bracts dry, membranous, brown-veined and rust-tipped, 5–6 mm long, inner usually shorter. *Flowers* 30–38 mm long, bilabiate, cream-white (rarely pale mauve) with yellow lower tepals and lower tube, lightly sweet-scented or without scent; *tube* 18–25 mm long, basal part 6–11 mm long, strongly curved at apex of narrow part; *tepals* unequal, inner cordate, upper largest, hood-like, 8–11 mm long and 8.5–11 mm wide in lower third, upper laterals ovate, 8–10 mm long, 6–7 mm wide; lower laterals horizontal, with margins upcurved, ca 8 mm long, ca 7 mm wide. *Filaments* 13–15 mm long; *anthers* 4–5 mm. *Style* branching towards apex of anthers. *Capsule* 6 mm high, 8 mm wide, 3 lobed, surface smooth (evidently). *Chromosome number*  $2n = 22$ .

Flowering time: late July to September.

Distribution: arid flats and slopes from Pietermeintjies and the Bonteberg north along the eastern slopes of the Swartruggens and Cedarberg to Calvinia. Fig. 11.

*Freesia occidentalis* is a species characteristic of the very arid eastern foothills of the western Cape mountains, and of the summer dry western Karoo. It ranges from Pietermeintjies and Touwsrivier, through the Bonteberg Karoo, Karoopoort and southern Tanqua basin, along the eastern edge of the Cedarberg to the Calvinia district. It is probably fairly common within its range, but grows largely in inaccessible and remote areas, hence the few collections known.

The type collection, *Compton 4273*, is said to have come from Nieuwefontein, northwest of Bitterfontein in Namaqualand but this is unlikely. The species has never again been found in Namaqualand. Investigation of Compton's collecting notes reveals that in September of 1932, when *F. occidentalis* was collected, he gathered only one species in Namaqualand, not a *Freesia*, but also that he collected several species in the Bonteberg-Tweedside area several hundred kilometres away, and within the known range of the species. Most likely the collection came from this area, but later became confused with specimens from Namaqualand.

*Freesia occidentalis* is closely related to *F. refracta*, a species of the Little Karoo and Worcester area, and to *F. corymbosa* of the eastern Cape Longkloof. Differences between these species are discussed under *F. refrac-*



FIG. 11.

Morphology and distribution of *Freesia occidentalis*: habit -  $\times \frac{1}{2}$ ; flowers -  $\times$  life-size.

*ta* and *F. corymbosa*. *Freesia occidentalis* is one of the few species of the genus not known in cultivation. This is a pity since it grows easily, and is particularly floriferous. The flowers are brightly coloured, but comparatively small for *Freesia*.

*Freesia framesii* is reduced to synonymy here. The type of this species was grown in Cape Town from corms originally from the Calvinia area. It represents the northern form of *F. occidentalis*.

S. AFRICA, CAPE—3119 (Calvinia): Wilgebos farm, S.W. Calvinia (-DA), Lewis 5880 (K, NBG, STE), Lavranos & Buller 8859 (MO); Driefontein, S.W. of Calvinia, Marloth 10429, 12815 (PRE, STE); farm Kareeboomfontein, W. of Re-bunie, Hanekom 2417 (K, M, MO, PRE, WAG); Boskloof Pass, S. Calvinia, Stayner s.n. (NBG 87525).

—3219 (Wuppertal): 15 km E. Matjesrivier, Agter Cederberg (-AD), Goldblatt 4069 (K, MO, NBG, S, WAG); farm Zuurfontein, near Doorn River, Owen s.n. (NBG 99951).

—3319 (Worcester): Touws River—Ceres road (-B), Thomas s.n. (NBG 93843, STE); Karooport (-BA), Herre s.n. (BOL), Compton 5408 (BOL, NBG), Dymond s.n. (Nat. Bot. Gard. 1967/33 in BOL), Barker 1977 (NBG), Hall 120, 286 (NBG); flats W. of Inverdoorn (-BB), Oliver 3513 (STE); Bonteberg (-BD), Compton 3733 (BOL, NBG).

—3320 (Montagu): poort N. of Pienaarskloof (-AA), Acocks 23682 (PRE); Pietermeintjies (-AD), Archer 812 (BOL).

Without precise locality: Calvinia district, Lavis s.n. (BOL 31512); Skaife s.n. (BOL 21366).

Locality doubtful: Cape—3018 (Hondeklipbaai): Nieuwefontein, 45 m N.E. Bitterfontein, (-DA), Compton 4273 (BOL, K)—probably from the Touwsriver-Tweedside area.

9. *Freesia corymbosa* (Burm. f.) N.E.Br., Kew Bull. 1929: 132 et J! S. Afr. Bot. 1: 15. 1935.

*Gladiolus corymbosus* Burm. f., Fl. Cap. Prod. 2. 1768. Type: S. Africa, Cape, without precise locality (cultivated in Europe), Burman s.n. (Herb. Burman, G, holotype).

*Tritonia odorata* Lodd., Bot. Cab. 19, tab. 1820, 1832; nomen nudum.

*Freesia odorata* Ecklon ex Klatt, Linnaea 34: 672. 1866; nom. superfl. pro *Gladiolus sparrmannii* Thunb.

*Freesia refracta* var. *odorata* (Klatt) Baker, Handbk. Irid. 167. 1892; et Fl. Cap. 6: 99. 1896

*Freesia armstrongii* Watson, Gard. Chron, ser. 3, 25: 195. 1898; Brown, J! S. Afr. Bot. 1: 13. 1935. Type: S. Africa, Cape, Humansdorp distr. (cult. Kew), Armstrong s.n. (K).

*Freesia metelerkampiae* L. Bol., S. African Gard. 17: 337. 1929. Type: S. Africa, Cape, exact locality not known (cult. Cape Town) *Metelerkamp* s.n. (Nat. Bot. Gard. 1739/26 in BOL, holotype).

*Freesia brevis* N.E. Br., S. African Gard. 23: 263. 1933. Type: figure in S. African Gard. 17: 336. 1927 (an illustration of the type of *F. metelerkampiae* when live).

*Freesia corymbosa* (Burm. f.) N.E.Br. var. *aurea* N.E.Br., J! S. Afr. Bot. 1: 16. 1935 nom. inval. sin. descr. lat.

Plants (160-)250–500 mm high. *Corm* globose-conic, to 25 mm in diameter, tunics medium to coarse, light brown, reticulate. *Leaves* linear-



ensiform, 100–200 mm long, basal, acute. *Stem* erect, smooth, usually much exceeding the leaves, usually several-branched. *Spikes* (3-)6–10 flowered; bract 3–4(-6) mm long, usually dry-membranous, brown-veined, and rust-tipped (rarely apices transparent), inner bract similar, sometimes slightly longer, or  $\pm$  equal, bi-apiculate. *Flower* 25–35 mm long, often without scent, typically pale yellow, with lower tepals bright yellow to orange, occasionally pink with yellow throat; *tube* ca 20 mm long, narrow lower part 4–10(-15) mm, upper part expanding rather abruptly, *tepals* unequal, upper largest, erect to somewhat hooded, to 12 mm long, and 10–12 mm wide, cordate, upper laterals ca 9 mm long, 5–6 mm wide, ovate-lanceolate, lower laterals ca 7 mm long, ca 7 mm wide, cordate,  $\pm$  horizontal, margins curved upward and overlapping lower tepal. *Filaments* ca 15 mm long; *anthers* 4–6 mm long. *Style* dividing just beyond apex of anthers. *Capsule* 6–8 mm long, rugulose, sometimes appearing smooth when ripe. *Chromosome number*  $2n = 22$ .

Flowering time: as early as May, but generally late August–October, locally to late November.

Distribution: from the Uniondale and Willowmore districts eastwards to East London and Butterworth, most common in sandy soils in the Longkloof and Port Elizabeth-Albany districts. Fig. 12.

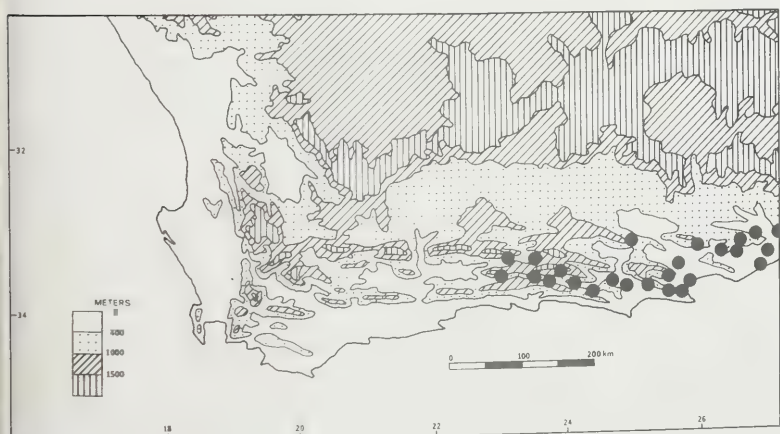


FIG. 12.

Distribution of *Freesia corymbosa* (one station, Bawa Falls, is outside the map area).

*Freesia corymbosa*, known until 1929 as *F. odorata*, was one of the first two species of *Freesia* known to science, having been described as *Gladiolus corymbosus* by Burman in 1768. The correct identity of Burman's plants remained unknown, until Brown examined the Burman herbarium in 1929 and realized that this name should be applied to plants then known as *F. odorata* Klatt. The species, sometimes also called *F. aurea* (a nomen nudum), was well known in Europe in the nineteenth century, but was frequently confused with the then poorly understood *F. refracta*. The variety *aurea* N.E.Br. refers to a particularly deep yellow flowered form of *F. corymbosa*, of horticultural importance at one time, and much used in early *Freesia* breeding.

*Freesia corymbosa* is closely related to both *F. occidentalis* and to *F. refracta*, and it is sometimes difficult to tell them apart. *Freesia refracta* has pale greenish to membranous bracts without the brown tip characteristic of *F. corymbosa*, as well as rather dull coloured flowers with a distinctive spicy scent. *Freesia occidentalis*, a species of the western margins of the Karoo and eastern slopes of the western Cape mountains, has bracts very like those of *F. corymbosa*, but generally smaller flowers and obtuse leaves in contrast to the typically tapering and acute leaves of both *F. corymbosa* and *F. refracta*. *Freesia corymbosa* is typically an eastern Cape species, but it extends west along the Longkloof to the Oudtshoorn district and east to East London and the border of the Transkei.

The rare pink-flowered *Freesia*, named *F. armstrongii* by Watson in 1898, is in my opinion no more than a colour form of *F. corymbosa*. The type collection originally came from near Hankey in the Gamtoos River valley and is uniformly pink except for the base of the tube which is yellow (see HORTICULTURAL HISTORY for details of its introduction to England). I have collected plants, Goldblatt 4935, matching the type in every respect and found them growing in deep red soil at the edge of dense bush. They had a faint but distinctly *Freesia*-like scent. This form differs from typical *F. corymbosa* mainly in the length of the basal part of the tube which is about 15 mm long. However, a similar tube length occurs in yellow flowered plants from Longmore Forest Reserve, not far to the east (e.g., Bayliss 7689, tube ca 10 mm) and from Addo and Enon (e.g., Bayliss s.n., tube ca 10 mm; Thode A2763, tube up to 17 mm) well to the north-east. These plants match *F. armstrongii* exactly except in colour.

South of Hankey, at Zuurbron and well to the west at Haarlem, pink-flowered forms much more like typical *F. corymbosa* occur. These plants have a shorter basal part of the tube (*Fourcade* 3331 & 5384, tube 4–6 mm long; *Stayner* s.n., tube ca 10 mm long and, in addition, yellow markings on the lower tepals). Plants collected "near Hankey," *Andrews* sub Galpin

4692, also have a short tube, and show signs of having had yellow markings on the lower tepals.

With this pattern of variation it is impossible to include pink-flowered plants in a separate species. Nor does it seem to be of value to separate longer tubed pink- and yellow-flowered plants together in a separate taxon given the degree of variation in quantitative features such as tube length found in all species of *Freesia*. Brown (1935:3) reports that this pink form of *F. corymbosa* was first collected by the English plant collector Bowie, and that a painting was made in 1826 of plants grown at Kew at this time.

*Freesia meterlerkampiae* L. Bol. is almost identical with collections made by Fourcade at Zuurbron, and probably comes from there. The type material, a cultivated specimen, is doubtfully assigned to the Robertson area. Brown (1935, p. 13) included it in *F. armstrongii*.

S. AFRICA, CAPE—3228 (Butterworth): Bawa Falls (-AC), *Taylor* 3633 (NBG).

—3322 (Oudtshoorn): W. end of Kransberg, upper Long Kloof (-DB), *Goldblatt* 4949 (BR, MO, WAG); Kammanassie, road to Laudina, *Oliver* 3596 (K, PRE, STE).

—3323 (Willowmore): Hills S. of Toorwater (-AC), *Oliver* 3658 (PRE, STE); Zuurberg, at Georgida (-AD), *Fourcade* 4626 (BOL, STE); Long Kloof, road to Bo Koega (-CB), *Rourke* 893 (NBG); near Haarlem, Long Kloof, *Stayner s.n.* (NBG 91316); near Misgund (-CD), *Compton* 7293 (NBG).

—3324 (Steytlerville): 6–1½ m E. Greystone (-BB), *Acocks* 23272 (PRE); Kareedow–Assegaaibosch (-CD), *Goldblatt* 2863 (MO); poort between Cambria and Patensie (-DA), *Thompson* 1888 (K, PRE, STE); Klein R., Hankey (-DD), *Long* 1349 (K, UPE); Hankey, *Paterson s.n.* (GRA); near Hankey, *Andrews s.n.* in Herb Galpin 4692 (K, PRE); 5.5 km N. Hankey, *Goldblatt* 5935 (K, MO, NBG, PRE, S); Zuurbron, *Fourcade* 3331 (BOL), 3978 (BOL, K), 5384 (PRE, STE); Oswald Meterlerkamps farm near Zuurbron, *Holland* 2213 (BOL).

—3325 (Port Elizabeth): Kommadagga (-BB), *Bayliss* 1569 (B); Enon (-BC), *Thode* A2762 (K, PRE); Addo bush, *Begley s.n.* (PRE 15775); Groendal, E. of Uitenhage (-CB), *Long* 1074 (GRA, K, PRE, UPE), *Schnarf* 1416 (PRE); Longmore Forestry Station (-CC), *Bayliss* 7689 (MO, NBG); Van Stadensberg, *Zeyher* 4026 (G, P, SAM); Uitenhage (-CD), *Loubser* 908 (NBG); Zwartkops, near sea (DC), *Theron* 1389 (BM, K, LD, PRE); Zwartkops, saline meadows, *Brock* 7 (GRA).

—3326 (Grahamstown): Grahamstown–Riebeeck East (-A), *Bayliss* 6748 (MO); Plutos Vale, Albany distr. (-BA), *Bayliss* 2333 (B, G, Z), 6755 (MO); 24 m E. Grahamstown, *Barker* 7013 (NBG); Breakfast Vlei, *Bokelman* 5 (NBG); near Grahamstown (-BC), *Burke s.n.* (K), *Rogers* 27576 (G, Z), *MacOwan* 90 (MO, SAM), *Atherstone s.n.* (GRA), *Guthrie* 3440 (NBG); brickfield W. Grahamstown, *Goldblatt* 2866 (MO); Grahamstown flats, *Galpin* 207 (K, PRE); between Blaauwkrans and Military Post, Bathurst distr. (-BD), *Burchell* 3711 (K); Bathurst (-DB), *Sim* 19892 (PRE); Bathurst distr., *Sidey* 2041 (S), 3827 (P, S).

—3327 (Pieddie): Line Drift-Peddie (-AA), *Sim* 4083 (PRE), 4089 (GRA).

Without precise locality: *Sparman s.n.* (S); hills between Zwartkops and Sundays R., *Ecklon & Zeyher* 286 (BM, GRA, K, S, SAM, STE), *Pappe s.n.* (BM); Albany distr., *Zeyher s.n.* (K), *Prior s.n.* (K); between Kariaga and Bushmans River at Jagersdrift, Albany Distr., *Ecklon & Zeyher Irid.* 108 (LD, MO, P, PRE).

10. *Freesia speciosa* L. Bolus, S. African Gard. 19: 385. 1929; Brown, Jl S. Afr. Bot. 1: 10. 1935. Type: S. Africa, Cape, Bonnievale-Barrydale (cult. Whitehill), *Archer s.n.* (BOL 19027, holotype).

*Freesia sparrmannii* var. *flava* Phillips & N.E. Br., Fl. Pl. S. Africa 1: tab. 11. 1921. Types: S. Africa, Cape, Ladismith distr., (cult. Pretoria), *Shand s.n.* (PRE 15786, holotype).

*Freesia flava* (Phillips & N.E. Br.) N.A. Br., Jl S. Afr. Bot. 1: 27. 1935.

Plants (80–)120–200 mm high including flowers. *Corm* conic, to 20 mm in diameter, with medium to coarse, light brown, reticulate tunics. *Leaves* straight to falcate, obtuse (–subobtuse), apiculate, usually shorter than the stem, unusually broad, to 20 mm wide. *Stem* erect, usually simple, (or up to 4 branched in cultivated material), smooth. *Spike* 3–6 flowered; *bracts* membranous, greenish below in early stages, becoming dry, brown-tipped, 8–10 mm long, inner bract slightly smaller. *Flowers* large, 50–70 mm long, pale yellow (evidently odourless), lower tepals deep yellow; *tube* 35–50 mm long, lower portion 14–20 mm, curved at apex of lower part; *tepals* 13–18 mm long, outer larger, broadly ovate, upper hood-like, 10–12 mm wide, lower laterals naviculate. *Filaments* 25–32 mm long; *anthers* 7–10 mm. *Style* dividing at mid-anther level or well beyond anther apex. *Capsule* unknown. *Chromosome number* unknown.

Flowering time: mid-August–September.

Distribution: Little Karoo, apparently scattered and rare. Fig. 13.

*Freesia speciosa* is the largest flowered species in the genus. It is poorly known, only a handful of collections having been made, all in the Little Karoo. It is probably most closely related to *F. andersoniae* which is native to the upper Karoo and Northern Cape. *Freesia speciosa* typically has obtuse to subobtuse, and rather broad soft-textured leaves, and yellow flowers usually 60–70 mm long with the tube over 40 mm, and broad, ovate inner tepals 12–15 mm at widest. *Freesia andersoniae* in contrast has narrower, acute leaves of rather rough texture, and pale, usually cream flowers 50–60 mm long with the tube 36–44 mm, and ovate inner tepals about 85 mm wide.

This species was first described as variety *flava* of the then poorly understood *F. sparrmannii* (Phillips & Brown, 1921) and later Brown (1935) raised this to specific rank, making a point of the rather long style, which in the type plant, extended beyond the top of the tepals. Louisa Bolus had in the intervening period described *F. speciosa*, which Brown recognized as distinct and, to judge from their widely separate position in his revision, considered unrelated. With a greater range of specimens available to me, I

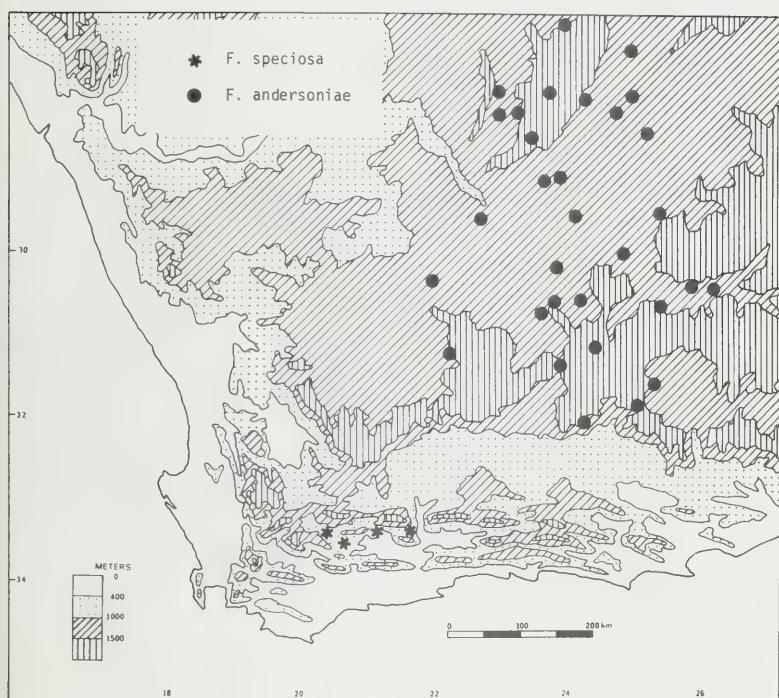


FIG. 13.

Distribution of *Freesia andersoniae* and *F. speciosa*.

have come to the conclusion that *F. speciosa* and *F. flava* are conspecific. The type specimens of the two species differ in minor features such as the length of the basal part of the perianth tube, degree of branching, and only the type specimen of *F. flava* has an exerted stigma. I cannot see any significance in this feature which is probably due rather to slightly abnormal growing conditions (the specimen was cultivated) than to a fundamental genetic difference.

*Freesia speciosa* was grown for a time in several Botanic Gardens in South Africa, and very successfully judging from the robust specimens made from the cultivated plants. It is no longer in their living collections, and is not known to be in cultivation elsewhere. With its very large yellow flowers, *F. speciosa* is undoubtedly a desirable garden subject.

S. AFRICA, CAPE—3320 (Montagu): Wittepoort. Laingsburg Div. (-AC) Barker 1976 (NBG); west end of Touwsberg (-DB), Wurts 1432 (NBG).



—3321 (Ladismith): near Calitzdorp (-DA), *Blackburn s.n.* (BOL 31500), (BOL 31501); *Herre s.n.* (BOL).

Without precise locality: Ladismith, *Krige s.n.* (Nat. Bot. Gard. 4671/14 in BOL); Ladismith district, *Shand s.n.* (PRE 15786); Bonnievale–Barrydale, *Archer s.n.* (BOL 19027, K).

11. ***Freesia andersoniae*** L. Bolus, S. African Gard. .8: 337. 1927; Brown, JI S. Afr. Bot. 1: 28. 1935. Types: S. Africa, Cape, Herbert Div., *Anderson 760* (BOL, lectotype); Syntype: near Hopetown (cult.), *Metelerkamp s.n.* (Nat. Bot. Gard. 1681/26 in BOL).

Plants 100–200 mm tall. *Corm* to 20 mm in diameter, conic, tunics light brown, fibres medium to coarse. *Leaves* several, linear-ensiform, acute, (50–)100–180 mm long, usually about as long as the stem. *Stem* erect, smooth, simple or 1–2 branched. *Spikes* horizontal 2–5 flowered; *bracts* dry-membranous, brown-veined, 7–10(–12) mm long, minutely rust-tipped; inner bract similar, usually ca 1 mm longer, acute or bi-apiculate. *Flower* sweet-scented, white to cream with yellow markings on the lower tepals and purple lines in the throat, 50–60 mm long; *tube* 36–44 mm long, curved towards apex of narrow part, narrow basal part 15–20 mm long; *tepals* unequal, inner 12–15 mm long, ovate, 8–9 mm wide, upper  $\pm$  erect, outer 12–15 mm long, to 7 mm wide, outspread. *Filaments* 18–25 mm long; *anthers* 8–10 mm long. *Style* dividing near apex of anthers. *Capsule* and seeds not known. *Chromosome number* not known.

Flowering time: (late May–) August–early October.

Distribution: rocky koppies and flats in the upper Karoo from Carnarvon and Middelburg, north to the Kaap Plateau and Kuruman hills of the Northern Cape, including the western Orange Free State, and southwestern Transvaal. Fig. 13.

*Freesia andersoniae* is the most widespread species of the genus, having been recorded from sites scattered throughout the upper Karoo, Northern Cape and the western Orange Free State. I have been told that it occurs in the south-western Transvaal but I have seen no collection from there. The species is still poorly known, and much undercollected.

Surprisingly, although the first specimens of this species were collected by William Burchell in the early nineteenth century and again by Harry Bolus in 1867, *F. andersoniae* remained unnamed until its re-collection in the twentieth century. It was described as recently as 1927 by Louisa Bolus.

*Freesia andersoniae* is related to *F. speciosa* of the Little Karoo, the two having similar dry bracts and large flowers. The narrow and acute leaves, together with its large pale flower, make *F. andersoniae* easy to distinguish

from other species of the genus. It is not in cultivation, except perhaps in gardens within its range. There is a fine illustration of *F. andersoniae* in *Wild Flowers of the Northern Cape* by Jill Adams (1976).

S. AFRICA, CAPE—2723 (Kuruman): between Takun and ruins of Old Litakun (-BB), *Burchell* 2269 (K).

—2724 (Taung): 10 m E. of Taung (-D), *Fock s.n.* (KMG 8218).

—2822 (Glen Lyon): 6 m W. Lucas Dam (-BB), *Fock s.n.* (KMG 8209, PRE); Beeshoek, 5 m W. Postmasburg (-BD), *Leistner & Joynt* 2700 (G, K, KMG, M, PRE, S, Z).

—2823 (Griekwastad): municipal ground, Postmasburg (-AC), *Hanekom* 2429 (K, MO, PRE); hill NW of Danielskuil (-BA), *Leistner* 1518 (KMG); Jasper hills, Groenwater, Hay distr. (-CB), *Acocks* 2435 (PRE).

—2824 (Kimberley): Klipfontein, Kimberley distr. (-A), *Wilman* 825 (KMG); Warrenton (-BB), *Adams* 149 (GRA, KMG, PRE); Windsorton (-BC), *Elliot s.n.* (KMG 2694, TVL 19594).

—2922 (Prieska): Prieska (-DA), *Bryant* 324 (K, PRE), *Fuller* 219 (BOL, PRE).

—2923 (Douglas): Katlani, dolerite ridge (-BA), *Bruekner* 761 (KMG); St. Clair, Herbert Div. (-BB), *Orpen* 280 (SAM).

—2924 (Hopetown): near Hopetown (-CA), *Taylor* 883 (BOL).

—3021 (Vanwyksvlei): Vanwyksvlei (-BD), *Alston s.n.* (SAM 20966).

—3023 (Britstown): Karoo near Britstown (-DA), *Schlieben* 9159a (PRE); Britstown district (-D), *Van Niekerk s.n.* (STE 10689).

—3123 (Victoria West): Richmond (-BD), *L. Bolus s.n.* (BOL 31499).

—3124 (Hanover): Hanover (-AB), *Vimpany s.n.* (Nat. Bot. Gard. 1685/31 in BOL).

—3125 (Steynsburg): below Witkransnek, Middelburg distr. (-CA), *Acocks* 21416 (PRE).

—3224 (Graaff-Reinet): Sneeubergen (-AA), *H. Bolus* 1806 (GRA, K, S).

ORANGE FREE STATE—2825 (Boshof): Boshof Koppies, 15 m from Kimberley (-CA), *Bruekner* 885 (KMG).

—2924 (Hopetown): mountain slopes above Vanderkloof Dam (-D), *Van Maanen s.n.* (NBG 109220).

—2925 (Jagersfontein): Fauresmith, Karoo Reserve (-CB), *Potts s.n.* (PRE), *Smith* 385 (PRE), 487/2 (PRE), 437 (Z); Samekoms Plateau, Fauresmith, *Kies* 246 (PRE).

—3025 (Colesberg): Bethulie, koppies (-BD), *Feinauer s.n.* (MO, NBG, PRE); Inhoek farm, Donkerpoort (-CB), *Fourie s.n.* (PRE).

—3026 (Aliwal North): Eedendal, TDR Wildplaas (-AC), *Muller* 1013 (PRE).

Without precise locality: Langeberg, Hay Division, *Hunter* 20 (PRE); "Roodehoogte" (? = Rooihoogte 3124-DD) Middelburg, *Theron* 862 (PRE); Conway farm, Middelburg distr., *Gilfillan s.n.* in Herb Galpin 5577 (GRA, PRE); S. of Strydenburg, *Taylor* 854 (BOL); Herbert Division, *Anderson* 760 (BOL); Fraserburg—Carnarvon, *Wall s.n.* (LD).

#### EXCLUDED SPECIES

*Freesia alba* Foster, Gard. Chron. 5, 3: 588. 1888 nom. inval. non auct. approb.

In the article in which Foster discusses *F. alba*, he makes it quite clear that he does not regard *F. alba* as a species. He believed the plant to be a form or variant of *Freesia refracta*. Nomenclaturally the name is invalid.

*F. angolensis* (Baker) Klatt, in Dur. & Schinz, Consp. Fl. Afr. 5: 187. 1895. *Anomatheca angolensis* Baker, basionym. = *Lapeirousia schimperi* (Asch. & Klatt) Milne-Redh.

*F. cruenta* (Lindl.) Klatt, in Dur. & Schinz, Consp. Fl. Afr. 5: 187. 195. = *Anomatheca laxa* (Thunb.) Goldbl.

*F. curvifolia* Klatt, nom. nud., identity unknown.

*F. gentilis* N.E. Br., Jl S. Afr. Bot. 1: 20. 1935.

Type: South Africa, Cape, cultivated at the Botanical Gardens, Cape Town, from corms said to have been collected by G. Alston at Vanwyksvlei, in Bushmanland (SAM 20966, holotype).

The type specimens of *Freesia gentilis* resemble closely the cultivated *Freesia*, or perhaps a form of *F. alba*. The tall plants have well developed, herbaceous bracts and very long flowers. No such plants have ever been collected near Vanwyksvlei, and the only species of *Freesia* native in this area is the very different *F. andersoniae*, which has dry, papery, brown-tipped bracts. Brown (1935: 20) mentions that Alston also collected corms of *F. andersoniae* at Vanwyksvlei, and sent those to the Botanic Gardens at Cape Town. It seems probable that corms of cultivated *Freesias* somehow became confused with corms sent by Alston from Vanwyksvlei. It is best to reject *F. gentilis* from *Freesia* until such time as more information comes to light on its origins.

*F. grandiflora* (Bak.) Klatt, in Dur. & Schinz, Consp. Fl. Afr. 1: 187. 1895. = *Anomatheca grandiflora* Bak.

*F. herbertii* Klatt ex N.E. Br., Jl S. Afr. Bot. 1: 14. 1935.

*Sparaxis herbertii* Klatt, Linnaea 34: 674. 1866. nom. nud.

The type of this species was lost when part of the Berlin herbarium was destroyed in World War II. There is, however, a drawing of the type in the Bolus Herbarium, University of Cape Town. The single plant has two flowers, much distorted in pressing. The flowers appear to lack the slender basal part of the perianth tube, characteristic of *Freesia*, or this part may have been broken or folded under the flower. Nevertheless the plant is almost certainly a green bracted species of *Freesia*, perhaps *F. alba* or a cultivated form of *F. leichtlinii*. The species must be excluded as available authentic material is insufficient for determination. *Freesia herbertii* is certainly not a species as yet unknown in the wild.

*F. juncea* (L.f.) Klatt, in Dur. & Schinz, Consp. Fl. Afr. 5: 187. 1895. = *Anomatheca verrucosa* (Vogel in Trew) Goldbl.

*F. muirii* N.E. Br., Gard. Chron. ser. 3, 92: 467. 1932 et Jl Afr. Bot. 1: 19. 1935. Types: S. Africa, Cape, Mossel Bay Division, Muir 4849 (K), 4849A (K, PRE).

*Freesia muirii*, as circumscribed by N. E. Brown appears to include two separate species and their hybrids. The type collections, made by Muir from the same locality include a single sheet of *F. leichtlinii* (Muir 4849) and several sheets (Muir 4849A) of plants which seem to be hybrids between *F. leichtlinii* and *F. alba*, as well as some plants that appear to be *F. alba*. The information about the type population supports this conclusion, for the population evidently comprised plants with pure white (*F. alba*) flowers sometimes tinged on the reverse of the tepals with lilac, and plants with pale yellow (*F. leichtlinii*) flowers. As Brown's concept of *F. muirii* included the whole range of forms the species should be rejected as most probably based on a mixed collection of two species and their hybrids.

*F. picta* N.E. Br., Jl S. Afr. Bot. 1: 21. 1935.

Type: S. Africa, Cape, cultivated at the National Botanic Gardens, from corms said to have been collected at Beaufort West by (?Mrs.) Black s.n. (BOL, as Nat. Bot. Gard. 1538/13, holotype).

The two plants comprising the type collection have herbaceous bracts, and large long-tubed flowers and closely resemble the cultivated *Freesia*, or perhaps a robust form of *F. alba*. No such plants are known from the Beaufort West area, from which they are reported to have been collected. Perhaps an error in labelling occurred in cultivation, or corms of the cultivated *Freesia* were sent to the National Botanic Gardens in the mistaken belief that they were native in the district. The idea that some confusion is involved over *F. picta* is reinforced by the presence in BOL of nearly identical specimens, also cultivated at the National Botanic Gardens, reportedly from Mossel Bay, also collected by (?Mrs.) Black. The confusion surrounding the origin of *F. picta*, and the likelihood of its being of horticultural origin, makes its exclusion here justified.

*F. rubella* Bak., Bull. Herb. Boiss. ser. 2, 1: 868. 1901.

Type: Mozambique, Delagoa Bay, *Junod* 166 (Z).

Brown (1935: 29) transferred this species to *Watsonia*, as *W. rubella* (Bak.) N.E. Br. However, I have examined the type material, of which there are three sheets in the Zurich Herbarium, and there is no doubt this species is a synonym of *Anomatheca grandiflora* Bak.

*F. xanthospila* (DC. in Red.) Klatt, Linnaea 34: 672. 1865–66.

*Gladiolus xanthospilus* DC in Red., Liliacées 3: tab. 124. 1807.

Type: illustration in Red., Liliacées 3: tab. 124; possible type specimen in Herb. De Candolle (G).

*Tritonia xanthospila* (DC) Ker ex Spreng., Syst. Veg. 1: 154. 1825.

The problem in matching *Freesia xanthospila* with a wild species lies in

the fact that it was based on cultivated material. Both type illustration and the possible type material in the De Candolle collection at Geneva show typical characteristics of *Freesia* grown under conditions of low light and too much water. The leaves are overdeveloped, and the stem almost straight and not flexed at the base of the inflorescence. The flowers appear distinctly bilabiate with the lower three tepals smaller (especially in the De Candolle specimen) and with yellow markings on all three.

It seems likely to me that *Freesia xanthospila* belongs either to *F. alba* as Klatt (1895) believed, or to *F. caryophyllacea* which I think more probable due to the presence of tepal markings on all lower tepals and an apparent bilabiate condition. The type figure of *F. xanthospila* in fact resembles rather well taller, shade-grown plants of the eastern form of *F. caryophyllacea* except in the oversized leaves. N. E. Brown (1935) essentially dodged the issue of the identity of *F. xanthospila*, which he recognized, but did not relate it to a wild S. African plant. Interestingly, Brown treated *F. leichtlinii* as a variety of *F. xanthospila*. It was Brown's contention that *F. xanthospila* could not be conspecific with *F. caryophyllacea* because it lacked the dense minute pubescence found on the stem of this species. The stem of the De Candolle specimen is lightly pubescent, just as one would expect of a shade-grown, well-watered plant.

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## NOTES ON *HAEMANTHUS* L.: THE IDENTITY OF *HAEMANTHUS* *AMARYLLOIDES* JACQ.

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### ABSTRACT

Baker's usage of the name *Haemanthus amarylloides* Jacq., in the *Flora Capensis* (1896), for a species from the eastern Cape and Transvaal, is considered to be mistaken. The correct name for *H. amarylloides* sensu Baker, is *H. montanus* Baker, while the name *H. amarylloides* Jacq. must be applied to a species from Namaqualand. *H. montanus* Baker and *H. amarylloides* Jacq., including a new subspecies *H. amarylloides* Jacq. subsp. *polyanthus* Snijman, are described and both subspecies of *H. amarylloides* Jacq. are illustrated.

### UITTREKSEL

NOTAS OOR *HAEMANTHUS* L.: DIE IDENTITEIT VAN *HAEMANTHUS* *AMARYLLOIDES* JACQ.

In die *Flora Capensis* (1896) word die naam *Haemanthus amarylloides* Jacq. deur Baker foutief gebruik vir 'n spesie uit die oostelike Kaapprovinsie en Transvaal. Die korrekte naam vir *H. amarylloides* sensu Baker is *H. montanus* Baker, terwyl die naam *H. amarylloides* Jacq. toegepas moet word op 'n soort uit Namakwaland. *H. montanus* Baker en *H. amarylloides* Jacq., insluitende 'n nuwe subspesie *H. amarylloides* Jacq. subsp. *polyanthus* Snijman word beskryf. Albei subspesies van *H. amarylloides* Jacq. word geïllustreer.

### INTRODUCTION

Baker in his *Handbook of the Amaryllidaceae* (1888) and the *Flora Capensis* (1896) applied the name *Haemanthus amarylloides* Jacq. to specimens collected from the eastern Cape Province and the Transvaal. Critical comparison of Jacquin's original description and accompanying plate, with the material cited by Baker as *H. amarylloides* Jacq., as well as several recent collections from the same area, reveal however, several discrepancies which are discussed below.

### FEATURES OF *HAEMANTHUS* *AMARYLLOIDES* JACQ.

*Haemanthus amarylloides* sensu Baker has inflorescences with 5-8 spathe valves, white flowers which age to a delicate pink and leaves which appear at the time of flowering. Jacquin's description in contrast states that the num-

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*Haemanthus amarylloides.*

FIG. 1.

*Haemanthus amarylloides* Jacq. Plate from Jacquin (1804, Table 408).

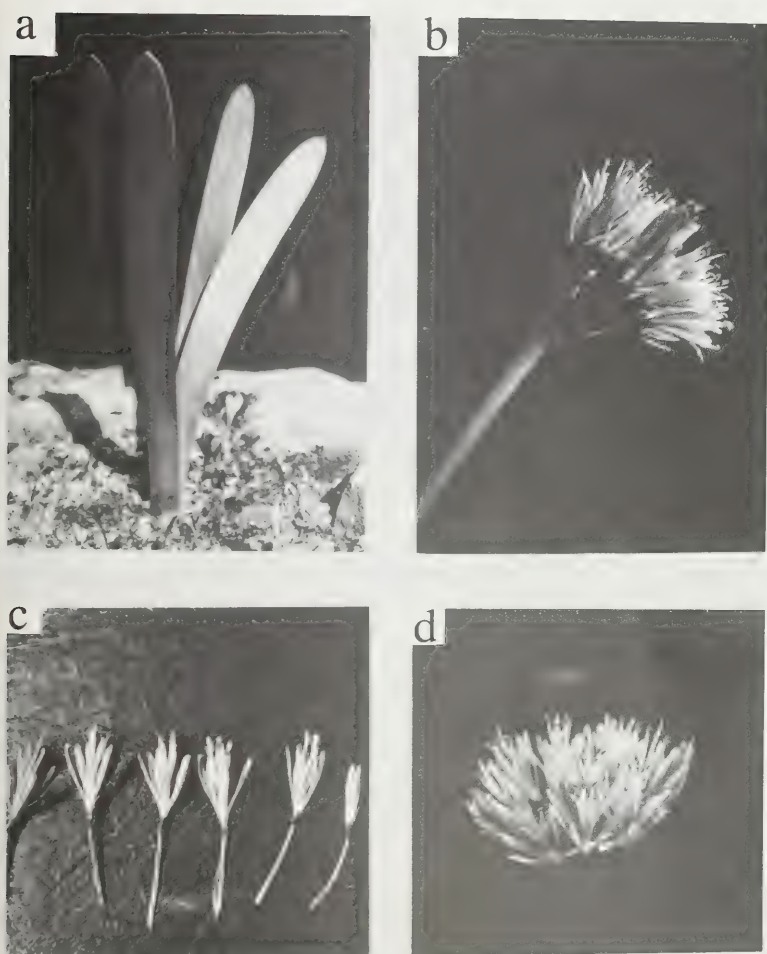


FIG. 2.  
*Haemanthus amarylloides* Jacq. subsp. *amarylloides* (M. Thomas, Vanrhyns Pass).  
 a, leaves  $\times \frac{1}{3}$  (two bulbs are depicted). b, d, inflorescence  $\times \frac{1}{2}$ . c, individual flowers  
 $\times \frac{3}{4}$ .



ber of spathe valves surrounding the umbel is 4, that the leaves are produced only after the inflorescence has withered and the colour of the flowers, as seen in Jacquin's plate, is rosy pink.

A much closer match with Jacquin's description are the fairly recent collections, *M. Thomas s.n.* and *W. F. Barker 9785*, from Vanrhyns Pass in the north-western Cape, as well as other gatherings from Namaqualand. These specimens, until now, have been included erroneously in the species *H. pumilio* Jacq., a species which, in the strict sense, is restricted to the Stellenbosch flats in the south-western Cape. *H. pumilio* differs in having consistently narrow (5–15 mm wide), twisted leaves. The Vanrhyns Pass specimens match Jacquin's description of *H. amarylloides* in all respects, notably the inflorescences which have 4 spathe valves, flowers which are always pink, and leaves which appear only after the inflorescences have died. The close similarity between Jacquin's plate of *H. amarylloides* and the Vanrhyns Pass collection of Thomas, is shown in Figures 1 and 2.

Evidence gathered by Salter and Stapf has shown that Jacquin's collectors Boos and Scholl travelled to Namaqualand in 1786 and 1787, at least as far as Garies (Garside, 1942). Goldblatt (pers. comm.) confirms this from his studies on the family Iridaceae. There is no doubt therefore that *H. amarylloides* could have been described by Jacquin from bulbs gathered by Boos and Scholl, in southern Namaqualand. This Namaqualand species was not known to Baker, thus it is understandable that he applied the name *H. amarylloides* to the somewhat similar, yet distinct, species, of which specimens were known to him at the time, from the eastern Cape Province.

This interpretation means that the name *H. amarylloides* Jacq., must be applied to the species from Namaqualand, now well represented in South African and overseas herbaria. This species, including a new subspecies, is described below and specimens are cited.

The species referred to by Baker as *H. amarylloides*, in the *Handbook of the Amaryllidaceae* (1888) and in the *Flora Capensis* (1896), is given the next available epithet, namely, *Haemanthus montanus* Baker.

#### SYSTEMATIC TREATMENT

***Haemanthus amarylloides* Jacq.**, Hort. Schoenbr. iv: 5 t. 408 (1804). Type: South Africa, Cape of Good Hope, Plate in Jacq., Hort. Schoenbr. iv: t. 408. 1804 (lectotype).

*Bulb* globose to pyriform, solitary or forming clumps, up to 70 mm diam., medianly compressed when young but circular or slightly laterally compressed in cross section when mature; tunics dying down obliquely, the dead parts remaining as a dark brown papery covering. *Leaves* 2, rarely 3, appearing after the inflorescence, erect, becoming prostrate when old, loriate

to oblanceolate, 100–260 (–340) mm long, (8–) 18–45 (–65) mm wide near the middle; blade flat, shiny green to yellowish-green on both surfaces, unmarked or sometimes flushed with maroon towards the base of the outer surface, glabrous; margin or the tip only sometimes reddened or thickened and opaque. *Peduncle* slender, up to 22 mm long, 7–12 mm by 4–5 mm wide, pink to deep wine-red, glabrous or densely hirsute with short stiff hairs. *Umbel* obconical to spherical, spreading, 40–75 mm across. *Spathe valves* 4–9, spreading and soon becoming reflexed, shorter than or equalling the flowers, triangular, 23–38 mm long, 4–11 mm broad at the base, pale pink to deep rose, sometimes with deep maroon mottling, membranous; tip acute. *Flowers* 15–115, lax, pale pink to rose. *Pedicels* (8–)10–15(–23) mm long, pale to very deep pink. *Perianth* 7–14 mm long; tube 0.5–2 mm long, smooth, narrowly funnel-shaped; segments spreading, linear to lanceolate, 6–12 mm long, 0.75–2 mm broad; tips obtuse to acute. *Filaments* exerted by 2–7 mm, pale pink to white above. *Anthers* 1–1.5 mm long when open, yellow. *Ovary* subglobose, 2–3 mm diam., greenish to maroon. *Style* slightly exceeding the stamens. *Berries* ovoidal to spherical, firm, about 10 mm diam., pale pink with a deep pink flush, in a loose cluster. *Seeds* 1–2, globose, reddish-brown.

Flowering time: March–April or a month earlier when in cultivation.

Leafing period: from May to October; usually the leaves are grazed back early in the season in areas stocked with goats and sheep.

Distribution: concentrated in Namaqualand between Springbok and the Kamiesberg, with a few outlying populations south, in the Nieuwoudtville area, restricted to elevations of 600 m or more.

*Haemanthus amarylloides* is distinguished from all the other species of *Haemanthus*, in which the inflorescences and leaves appear separately, by the following characters. The leaves are erect, lorate, 8–65 mm wide and glabrous. The blades are flat, shiny green and unmarked. The umbel of pink, loosely arranged flowers, is surrounded by 4–9 spreading pink membranous spathe valves.

The species is considered here to have two subspecies. These differ to some extent in geographical range and in the morphology of the inflorescence. Some overlap, in the distribution of both subspecies, occurs at Grootvlei, but the morphological differences between populations north and south-east of this area are considered constant enough to constitute separate subspecies.

#### KEY TO THE SUBSPECIES

- Spathe valves 4–5; number of flowers per umbel 15–40; perianth 12–14 mm long, rarely less; segments 1.5–2 mm wide ..... a. subsp. **amarylloides**
- Spathe valves 6–9, rarely 5; number of flowers per umbel 50–115, rarely less; perianth 7–10 mm long; segments 0.75–1.5 mm wide ..... b. subsp. **polyanthus**



FIG. 3.

*Haemanthus amarylloides* Jacq. subsp. *polyanthus* Snijman (Snijman 190, Grootvlei)  
1, inflorescence  $\times \frac{3}{4}$ . 2, flower  $\times 1\frac{1}{2}$ . 3, half flower  $\times 2\frac{1}{4}$ . 4, bulb  $\times \frac{3}{4}$ . 5, leaves  $\times \frac{3}{4}$ .

a. subspecies **amarylloides**

*H. amarylloides* (Jacq.) Herbert, Amaryllid: 233 (1837), (as *H. amaryllidioides*, orth. var.).

*Melicho amarylloides* (Jacq.) Salisb., Gen.: 130 (1866).

*Amaryllis haemanthoidea* Tratt., Gartenpfl.: 38 (1821), nom. superf.  
Type: As for *H. amarylloides* Jacq.

*Leaves* erect, lorate, 100–250 mm long, 8–40 mm wide, occasionally with thickened opaque margins. *Peduncle* slender, glabrous. *Umbel* obconical. *Spathes* valves 4, occasionally 5, pink, usually with some dark maroon mottling when dried. *Flowers* 15–40, pink. *Perianth* (10–)12–14 mm long; tube 2 mm long; segments oblanceolate (8–) 11–12 mm long and 1.5–2 mm broad. *Filaments* exerted by up to 3 mm.

Distribution: Localised populations occur at Grootvlei and on the escarpment near Nieuwoudtville. The habitat ranges from granite derived soils and Namaqualand broken veld in the north-west to Table Mountain Sandstone derived soil and fynbos in the south-east (Fig. 4).

CAPE—3017 (Hondeklipbaai): Grootvlei (-BB), Compton sub NBG 236/45 (NBG), Müller-Doblies 79199 (NBG).

—3119 (Calvinia): Top of Vanrhyns Pass (-AC), Thomas s.n. (K, NBG, PRE), Barker 9785 (NBG); Clousskraal, Mostert sub Marloth 13486 (PRE); Nieuwoudtville, Barker 9669 (NBG).

b. subspecies **polyanthus** Snijman, subsp. nov.

Differt a subsp. *amarylloides* valvis spathaceis 5–9, floribus (40–)50–115, perianthiis 7–10 mm longis, segmentis 0.75–1.5 mm latis.

Type: South Africa, Cape Province, 8 km west of national road towards Grootvlei, fl. 28/3/1981, Snijman 415 (NBG, holotype; K, MO, PRE, isotypes). (Fig. 3).

*Leaves* erect, lorate to oblanceolate, 140–340 mm long, 25–65 mm wide. *Peduncle* glabrous or rough with short stiff hairs. *Umbel* becoming spherical. *Spathes* valves (5–)6–9, pink. *Flowers* (40–)50–115, light pink. *Perianth* 7–10 mm long; tube 1–2 mm long; segments linear 6–8 mm long, 0.75–1.5 mm wide. *Filaments* exerted by 3–5 mm.

Distribution: Populations of approximately twenty or more individuals colonise habitats which are seasonally wet, either in poorly drained flat areas, furrows or seasonal stream beds. The distribution ranges from Springbok to the Kamiesberg in the south (Fig. 4).

CAPE—2917 (Springbok): farm Biesjesfontein, south of Springbok (-DB), *Snijman 420* (K, NBG, PRE); 17 km from Spektakel turnoff towards Komaggas (-DC), *Snijman 185* (NBG, PRE).

—3017 (Hondeklipbaai): ascending Killians Pass from the west (-BA), *Snijman 189* (NBG, PRE); 4.7 km east of Grootvlei (-BB), *Snijman 190* (K, NBG, PRE); farm Skilpad, north of Grootvlei, *NBG Expedition 370/67* (NBG); Bowesdorp, 8 km north of Kamieskroon, *Hall 4195* (NBG); 8 km west of national road towards Grootvlei, *Snijman 415* (K, MO, NBG, PRE); 1 km north of Darters Grave (-BD), *Snijman 192* (NBG, PRE), *Snijman 413* (MO, NBG); Karkams, *Snijman 411* (K, NBG, PRE).

—3018 (Kamiesberg); eastern slopes of Welkom, Kamiesberg (-AC), *Snijman 312* (NBG, PRE).

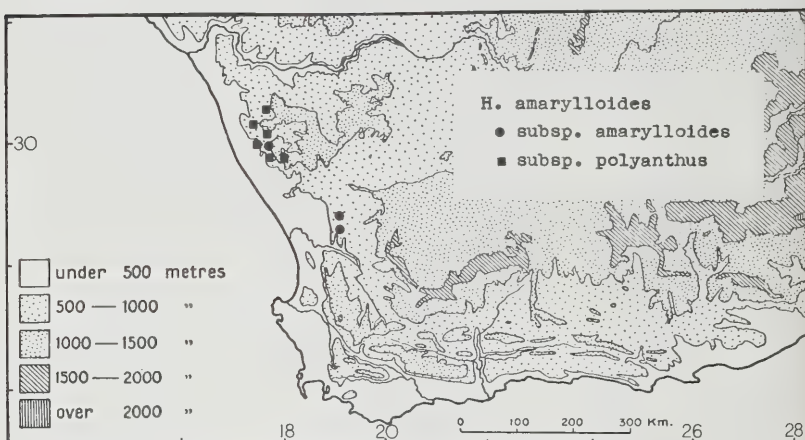


FIG. 4.  
Distribution of *Haemanthus amarylloides* Jacq.

*Haemanthus montanus* Baker in Flora Cap. VI: 234 (1896).

Type: South Africa, Natal, in valley of Buffalorivier near Charlestown, 5 000–6 000 ft, fl. 8/12/1892, *Wood 4810* (K, holotype; BM, E, PRE, isotypes).

*H. amarylloides* sensu Baker, Handb. Amaryllid.: 68 (1888) and in Flora Cap. VI: 234 (1896); sensu Sealy in Curtis's bot. Mag. N.S. **174**: t. 415 (1963); sensu Friis and Nordal in Norw. J. Bot. **23**: 70 (1976) excl. *H. pumilio* Jacq.

*Bulb* ovoid to pyriform, solitary or in clumps, up to 80 mm diam., circular to slightly compressed in cross-section; tunics thick, the edges dying back slightly obliquely, the outer tunics becoming papery and dark brown. *Leaves* 2, occasionally 3, appearing at the time of flowering, rarely a little later,



erect, narrowly to broadly lorate, 150–250 mm long, 15–50 mm broad near the middle; blade flat or sometimes twisted, green or glaucous, without markings, glabrous; margin sometimes raised or opaque; tip obtuse. *Peduncle* up to 400 mm long, 7–12 mm across, green to reddish, glabrous. *Umbel* becoming hemispherical, 40–90 mm across. *Spathe valves* 5–8, spreading and soon becoming reflexed, shorter or longer than the flowers, triangular 30–40 mm long, 4–13 mm wide at the base, pale pink, membranous; tip acute. *Flowers* 30–70 or sometimes more, spreading, white, tinged with pink when old. *Pedicels* 10–20 mm long, green. *Perianth* 10–14 mm long; tube 1–2 mm long, somewhat funnel-shaped; segments spreading, lanceolate, 9–13 mm long, 1–2 mm wide; tips acute. *Filaments* slightly exerted, at most by 3 mm, white. *Anthers* 1.5–3 mm long when open, yellow. *Ovary* subglobose, approximately 2 mm diam. *Style* equalling the filaments. *Berries* not seen.

Flowering time: October to December.

Leafing period: appearing from October to December and dying back early in winter.

Distribution: eastern regions of southern Africa, from as far south as King William's Town in the Cape, to the midlands of Natal, the Orange Free State and the Transvaal highveld. Populations of 20 to 200 individuals occur in grasslands either along river banks, poorly drained flats or periodically dry vleis (Fig. 5).



FIG. 5.  
Distribution of *Haemanthus montanus* Baker.

The inflorescence of white flowers, surrounded by 5–8 spreading pink spathe valves and the lorate (15–50 mm wide), erect, glabrous leaves which usually appear at the same time as the inflorescence, are all features which, considered together, distinguish *H. montanus* from other species in the genus.

TRANSVAAL—2530 (Lydenburg): 50 miles east of Carolina (-DC), *Reynolds 2143* (PRE).

—2627 (Potchefstroom): 7 miles east of Welverdiend (-AD), *Louw 71* (PRE); near Mimosa Park, Potchefstroom (-CB), *Louw 1100* (PRE).

—2628 (Johannesburg): near Premier Paper Mills, Germiston (-AA), *Codd 4470* (K, PRE); Henley-On-Klip (-CA), *Moss s.n.* (K), *Moss* sub NBG 651/41 (NBG); spruit near Val station (-DD), *Smuts 391* (PRE).

—2629 (Bethal): near Vaal River, Standerton (-CD), *Sim 3590* (PRE); 4 miles west of Morgenon (-DA), *Mauve 4464* (K); Vereeniging (-DB), *Leslie 10909* (PRE).

—2630 (Carolina): Steynsdorp (-BB), *Dieperink 140* (PRE).

—2725 (Bloemhof): Jantjieshoek, 12 miles north-east of Wakkerstroom (-AC), *Devenish 179* (PRE); Thornhill farm, Wolmaransstad (-BB), *Mainwaring 2794* (PRE); Pringles farm, Christiana (-CC), *Burt-Davy 5539* (PRE).

—2731 (Louwsburg): 25 miles north-west of Pongola settlement on road to Piet Retief (-BC), *Codd 2105* (PRE).

ORANGE FREE STATE—2727 (Kroonstad): Heilbron (-BD), *Goosens 521* (PRE); farm Rondavel Noord, west of Kroonstad (-CA), *Scheepers 1752* (PRE); 12,8 miles from Lindley on road to Heilbron (-DD), *Marais 1092* (K, PRE).

—2728 (Frankfort): Villiers (-BA), *Kresfelder s.n.* (PRE).

—2826 (Brandfort): farm Peilkop (-CC), *Bourquin 853* (PRE); Glen (-CD), *Heyiule s.n.* (PRE).

—2926 (Bloemfontein): 13 miles north of Bloemfontein (-AA), *Archibald 6129* (GRA).

NATAL—2729 (Volksrust): in valley of Buffalo river, near Charlestown (-DB), *Wood 4810* (BM, E, K, PRE).

—2829 (Harrismith): near Colenso (-DB), *Mauve 4464* (K, PRE); 5 km from turn-off outside Estcourt towards Weenen (-DD), *Van Rensburg 95* (E).

CAPE—3126 (Queenstown): Queenstown (-DD), *Galpin 1676* (GRA, K, PRE), *Everitt s.n.* (PRE), *Koopowitz s.n.* (GRA).

—3128 (Umtata): Gcigcira near Baziya (-CB), *Baur 568* (K, SAM); Munya near Idutywa (-CD), *Evans s.n.* (GRA, PRE).

—3226 (Fort Beaufort): Kagaberg (-CA), *MacOwan 2248* (SAM).

—3227 (Stutterheim): 5 miles south of Cathcart on the Hogsback road (-AC), *Archibald 6097* (GRA).

—3327 (Pieddie): Line Drift near King William's Town (-AA), *Leighton* sub NBG 272/32 (BOL).

Inexact localities: Mooi River, Bechuanaland, *Zeyher 1655* (SAM); Buffelshoek, Magaliesberg, *Gilfillan 1406* (PRE); Bamboespruit, *Nelson 244* (K); lower Klipriver, Moss herb. 26866 (PRE); Klip River Valley, *Moss 13806* (BM); Klip River on road from Vereeniging, *Verdoorn 2343* (PRE); Mooi River, Transvaal, *Burke* (K, SAM); Modder River near Bloemfontein, *McNeil s.n.* (K); Kroonstad district, *Pont 523* (PRE); hills between Bedford and Esterhuysens Poort, *MacOwan 2248* (K); between Grahamstown and Bedford, *Dyer 2324* (K); between Gekau and Bashee Rivers, *Drège 4524* (BM, E, K); between Hogsback and Cathcart, *Barker 2352* (NBG).

Doubtful locality: Oudtshoorn, *Ryder 94* (K).

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REFERENCE

GARSDALE, S., 1942. Baron Jacquin and the Schönbrunn Gardens. *Jl S. Afr. Bot.* **VIII**: 200-224.



## THE AFRICAN GENUS *TRITONIA* KER-GAWLER (IRIDACEAE): PART 1

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### ABSTRACT

Herbarium material and living plants from their natural habitats have been examined for this revision of *Tritonia* Ker-Gawler, an Iridaceous genus found in Africa south of the equator and concentrated in the Republic of South Africa. An anatomical study of the leaves provided useful diagnostic characters, but cytological data were of minor importance.

A new subgeneric delimitation with five sections is established. Three, namely sections *Tritonia* (with four species), *Pectinatae* (four species) and *Teretifoliae* (one species), from the winter rainfall region of the Cape Province except for one species from the Karoo, are treated in the present paper. The two last named sections differ from other sections in their leaf structure. Illustrated descriptions of the species, their geographical distribution and synonymy, as well as a key are provided.

### UITTREKSEL

#### DIE GENUS *TRITONIA* KER-GAWLER (IRIDACEAE) IN AFRIKA: DEEL I

Herbariummateriaal en lewende plante vanuit hul natuurlike habitats is ondersoek vir hierdie hersiening van die genus *Tritonia* Ker-Gawler (familie Iridaceae), 'n genus van Afrika suid van die ewenaar en gekonsentreerd in die Republiek van Suid-Afrika. 'n Anatomiese studie van die blare het bruikbare differensiële kenmerke opgelewer, maar sitologiese gegewens het min bygedra.

'n Nuwe subgeneriese indeling met vyf seksies is ingestel. Drie, nl. seksies *Tritonia* (vier spesies), *Pectinatae* (vier spesies), en *Teretifoliae* (een spesie), uit die winterreënvalstreek van Kaapland behalwe vir een spesie uit die Karoo, word in die huidige artikel behandel. Die twee laasgenoemde seksies verskil van die ander in hul blaarbou. Geïllustreerde beskrywings, die geografiese verspreiding en die sinonimie van die spesies, asook 'n sleutel word aangegee.

### INTRODUCTION

*Tritonia* is an African genus of the Iridaceae, subfamily Ixioidae, and comprises some 30 species. The greatest concentration of species is in the southern coastal districts of the Cape Province of the Republic of South Africa (R.S.A.), the range of the genus extending throughout the Cape Province, Natal and Transvaal, and into the Orange Free State, Lesotho, Swaziland, and the eastern Central African countries up to the equator. (See p. 114).

Species of *Tritonia* became known in Europe and England during the second half of the eighteenth century, and from that time onwards several

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species were described and figured as species of *Ixia* and of *Gladiolus*. In 1802 Ker-Gawler gave the genus its name, observing that "the name is derived from Triton, in the signification of a vane or weathercock, in allusion to the variable direction of the stamens of the different species".

During the nineteenth and twentieth centuries numerous species were described as *Tritonia*. The *Index Kewensis* lists some 105 names, but Baker, who gave the most recent comprehensive rendering of the genus in the *Flora Capensis* (1896) and *Flora of Tropical Africa* (1897), treated 31 species in the former and five species in the latter. Considerably more than half the number of species under *Tritonia* belong to other genera; or their names should go into synonymy.

The present revision is based on the study of fresh material of most of the species in the R.S.A., as well as herbarium material of all the species, from local and overseas herbaria. The question of the relationships of *Tritonia* with *Montbretia* and *Crocasmia* has also been investigated. The genus is now again divided into five sections. Three sections, comprising species from the winter rainfall region of the Cape, are treated in the present article.

#### MORPHOLOGY

*Habit.* Tritonias are small to medium-sized herbaceous deciduous geophytes varying in height from ca. 150 to 500 mm or sometimes up to almost a metre.

The underground stem is a tunicated corm which lasts about a year, a new corm being formed annually.

The majority of species are adapted to winter rainfall conditions, the corm remaining dormant throughout the long dry summer months and sprouting after winter rains have started in autumn. They flower in spring and early summer. After the ripening of the seeds in early or later summer, the shoots wither. A small number of species are adapted to summer rainfall conditions and sprout in spring, flowering in summer or autumn.

Reproduction is by cormlets from axillary buds on the corm, as well as by seeds.

*Corm.* The corm is typical of the tribe *Ixieae*, comprising several internodes, with a narrow central stele surrounded by a wide starch-containing cortex and covered with tunics which are the remains of old leaf bases. The tunics are composed of fine to somewhat coarser fibres which are usually reticulate in the upper half of the corm and almost parallel in the lower half, the soft intercostal parts of the leaf bases having disintegrated.

One or sometimes more shoots develop from the uppermost axillary buds on the corm. During the growing season a new corm for the next season is gradually formed by the swelling of the basal internodes of the shoot.

When more than one shoot develops, a small group of independent corms is then formed.

One or more cormlets may also be produced from lower axillary buds on the corm. In *T. moggii* a stolon, several centimetres in length, may develop with a small cormlet at its end.

The old corm is gradually depleted of its food-materials and withers. Its roots, however, remain functional during the entire growing season, the new corm and cormlets usually producing roots at the beginning of the next growing season.

The corms are almost symmetrical and usually rotund or ovoid or almost cone-shaped with a rounded base. In section *Tritonia* they are squat and depressed; *T. florentiae* has a vertically elongated corm consisting of about seven internodes.

*Stem.* The above-ground stem (scape) is well-developed, slender, erect or suberect, and with its inflorescence usually overtops the leaves. Rarely (*T. florentiae*) it is short, hardly extending above-ground. It is simple in small plants; in larger plants one, two or three branches are often formed at the base of the inflorescence, each also bearing a number of flowers.

*Leaves.* A series of four or five cataphylls develops over the growing point on the corm. When this meristem starts growing out to form the shoot, the cataphylls elongate, protecting the young foliage leaves until these reach above-ground.

The cataphylls are distichously arranged, bifacial and colourless. They are closed in their lower half, tightly sheathing the developing shoot. In the fully developed shoot they have withered and cannot usually be distinguished.

Several foliage leaves develop, in a distichous, equitant, often fan-like arrangement. The lower leaves extend from nodes on the corm and others from the base of the scape. In some species the lowermost foliage leaf is shorter than the other leaves, with a shorter unifacial lamina. The upper cauline leaves, few in number, usually subtend side branches of the scape. They are shorter and narrower than the basal leaves and are almost bract-like and largely bifacial.

The leaf sheath is long and bifacial and the lamina is lanceolate, linear-lanceolate or linear, and rarely (*T. kamisbergensis*) wiry and subterete. In most species it is of the ensiform-unifacial type. Interesting variations occur in section *Pectinatae* where the lamina, although unifacial, is not typically ensiform. In *T. cooperi* it has four longitudinal flanges or ridges and is H-shaped in transverse section; in *T. crispa* and *T. lancea*, although apparently ensiform in shape, it is formed by two longitudinal flanges extending from

the abaxial surface, which are homologous with two of the four flanges of *T. cooperi* (De Vos, 1982).

Except in the section *Pectinatae* the veins occur in two rows in opposite pairs. Throughout the genus a pair of large (the largest) vascular bundles, each surrounded with a sclerenchymatous sheath, is present in the middle of the lamina, forming a pseudo-midrib. Between them there is a strip of colourless water-storing parenchyma. In a few species from the summer rainfall regions, namely *T. lineata*, *T. rubrolucens* and *T. strictifolia*, two large veins, joined by a fibre strand, occur near each leaf margin. Although clearly visible in herbarium specimens, they are not so evident in fresh material. This character helps in distinguishing these species.

*Tritonia* differs from *Ixia* in the almost universal absence of subepidermal sclerenchyma in the leaf margins. In most species of *Tritonia* the margins are strengthened by a thickened epidermis only, the lumen of these cells being almost completely obliterated by the thickened cellulosic cell walls. Only rare exceptions occur, namely *T. marlothii* and *T. delpierrei*, where a small vascular bundle accompanied by a large strand of subepidermal sclerenchyma, occurs in each margin. In some species, e.g. those of section *Pectinatae*, as well as *T. watermeyerii*, the leaf margins have no strengthening tissue at all.

Leaves with crisped and (or) undulate margins occur in *T. crispa* and *T. tugwelliae*, as well as in the incompletely known *T. undulata*. In *T. watermeyerii* the thin-textured leaves are spirally twisted.

In a few species, especially *T. bakeri*, *T. delpierrei* and *T. kamisbergensis*, the leaves are thickened and contain a colourless water-storing parenchymatous tissue in the centre between the layers of subepidermal chlorenchyma.

Large numbers of tanniniferous cells occur, scattered in the mesophyll and epidermis of most species. In *T. lineata* and *T. rubrolucens* the large amounts of tannin in the leaf epidermis cause the leaves to turn reddish brown or dark brown after drying out.

*Inflorescence.* The spike, which is dense or lax, is simple, or develops one, two or rarely more branches from its base, each branch subtended by a small bifacial cauline leaf. Four to twelve or more flowers are present on the main axis. The branches have fewer flowers which open later than those on the primary axis.

In the bud stage the flowers are arranged in a characteristic dense, flat, distichous manner. When they open, the spike usually becomes secund or almost secund and in section *Pectinatae* it is somewhat pectinate, because the scape bends below the spike.

Each flower is subtended by two spathe valves (bracts) which become

membranous, dry and brownish after the flower has opened. They cover the ovary and base of the perianth tube. The outer bract is usually 3-toothed or varies from acuminate to bidentate (the central tooth being aborted), to 5-toothed, or it may be irregularly lacerated. Several slender veins are present and the upper half is often minutely striped or speckled. The inner bract invariably has two veins and is bidentate or shortly bifid, with two acute or acuminate teeth. The two bracts are equal in length or the outer is sometimes slightly longer than the inner, e.g. in *T. nelsonii*.

*Flowers.* In the winter rainfall region of the Cape the flowering period is spring to early summer. Exceptions are two species from the eastern extremity of the winter rainfall region in the Eastern Cape Province, namely *T. dubia* which flowers in late winter and *T. laxifolia* which flowers in late summer and autumn. Farther east and north flowering occurs mainly in summer. Flowers last several days and close slightly in the evening.

*Perianth.* In four sections of the genus the flowers are zygomorphic, the posticous perianth segment being largest and usually erect or suberect and often concave or somewhat hooded, thus protecting the anthers and stigmas which are placed against this segment. The other five segments are spreading or sometimes slightly reflexed. In some species the three anticus segments give the impression of a lower lip, and in the majority of species a honey-guide is present on these segments, in the form of a median yellow or red stripe.

Exceptions are section *Tritonia* and also *T. bakeri* of section *Subcallosae* where the flowers are almost regular (in *T. dubia* completely so) with spreading perianth segments.

In sections *Tritonia* and *Pectinatae* the flowers are often wholly or partially inverted by a twisting of the perianth tube, thus placing the posticous segment in an anterior or lateral position. This was first observed by Ker-Gawler (1803a) who noted that "the reversed position of the organs of fructification . . . is perhaps generally the consequence of the reclined position of the rachis". It also happens, however, when the scape is erect.

The length of the perianth tube compared with that of the segments is of some diagnostic value. In section *Tritonia* the tube is shorter than the segments and shortly funnel-shaped; in sections *Pectinatae* and *Teretifoliae* it is longer than the segments and narrowly tubular in the lower portion, dilating gradually in the upper half or third. In the other two sections species occur with tubes shorter, and others with tubes up to several times longer, than the segments.

In section *Montbretia* a yellow peg-like or thin plate-like protuberance occurs at right angles to the surface, in the median line at the base of the three lower perianth segments. De Candolle (1803) established the genus

*Montbretia* for species with this character, describing the genus as having "auriculae tres, callosae, sessiles, perpendiculares, in laciniarum trium inferiorum pagina supera solitariae". In the literature they were compared with hatchets (thus the epithet *securigera*) and were described as crests, appendages, calli, a "mamelon allongé" (Redouté, 1804) and "une ecaille élevée" (Lamarck, 1789). Preference is now given to the term callus.

Calli differ somewhat in shape (Fig. 1), being peg-like in *T. laxifolia* for example, 3–4(–5) mm high and hardly 1 mm wide and slightly curved towards the base of the flower, and in the closely related *T. securigera* usually plate-like and almost equal in height and width, except towards the eastern extremity of the range of this species where they also are peg-like; in *T. florentiae* they are almost triangular and have a slightly undulate upper edge.

Stapf (1924) stated that a small amount of viscid matter was exuded from the tips of the calli in *T. laxifolia*. This could not be verified. The function of the calli is probably to diminish the space in the throat of the perianth, thus ensuring that a visiting insect will brush with its back against the anthers and stigmas.

Vestiges of calli also occur in the majority of species of section *Subcallosae* (therefore the name) and section *Tritonia*. In *T. pallida* (Fig. 1e),

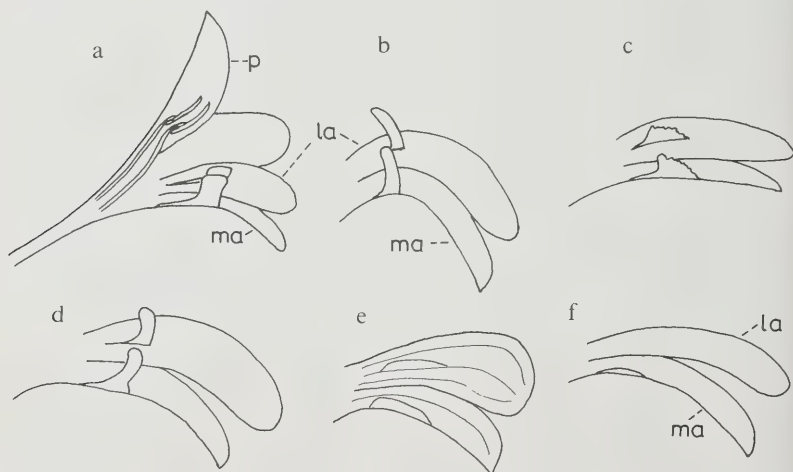


FIG. 1.

Calli on perianth segments of *Tritonia* species: a. *T. securigera*, median section through perianth; b–f, a lateral, and half of the median anticous perianth segment, of: b, *T. laxifolia*; c, *T. florentiae*; d, *T. watermeyeri*; e, *T. karooica*; f, *T. pallida*. la, lateral anticous segment; ma, median anticous segment cut in half; p, median posticous segment cut in half.



*T. lineata* and *T. rubrolucens* of the former section, as well as in *T. crocata* and *T. deusta* subsp. *miniata* of the latter section, the callosities are in the form of low median ridges, usually less than 1 mm in height, on the claw of the median, or all three, anticus perianth segments. In *T. deusta* subsp. *deusta* a callus occurs on the three outer segments, each as dark as the reddish-black blotch surrounding it. These were noted by several earlier workers, such as Aiton (1789), Willdenow (1797) and Ker-Gawler (1803b). Unfortunately the calli in species of sections *Tritonia* and *Subcallosae* are difficult to recognise in herbarium material.

The presence of calli in sections *Tritonia* and *Subcallosae* has led to the conclusion that the genera *Montbretia* and *Tritonia* are so closely related that they should not be kept separate. In the present revision *Montbretia* is therefore merged with *Tritonia*, as has also been done by Bentham and Hooker (1883), Baker (1896), Diels (1930) and Phillips (1951).

*Stamens and pistil.* The stamens are inserted in the upper portion of the perianth tube where it widens, and the filaments are shortly decurrent within the tube. In the majority of species the stamens and style are unilaterally curved and inclined towards the posticus perianth segment and often stand against this segment, with the anthers contiguous, facing the anterior side of the flower and dehiscing towards that side. Exceptions occur in section *Tritonia* where the stamens and style are at first slightly inclined towards the posterior side but soon become randomly curved and spreading, with the anthers facing any direction. In *T. dubia* the stamens and style stand erect in the middle of the flower with the anthers extrorse, but later they often tend to curve randomly. *T. bakeri* also has almost erect stamens and style.

The anthers are shortly linear, straight or somewhat falcately curved, and usually 5–8 mm in length. They dehisce by means of longitudinal slits and are versatile, attached to the filaments about one quarter the distance from their bases. In a number of species they are violet or purple or have a violet line down each side.

The pollen is cream, violet or greyish-mauve. The grains are monocolpate, and (70–)80–100(–110)  $\mu\text{m}$  in length in the dried condition. The exine is punctategillate, with sparsely scattered fine granules on the surface (Fig. 2).

Septal nectaries occur in the ovary top. Nectar rises in the perianth tube through capillary action. Pollination is by insects which land on the anterior side of the flower and brush with their backs against the anthers and stigmas above them. In section *Tritonia* they land anywhere.

Except for the position and length of the style, the pistil has little diagnostic value for distinguishing the species. The trilocular ovary with its

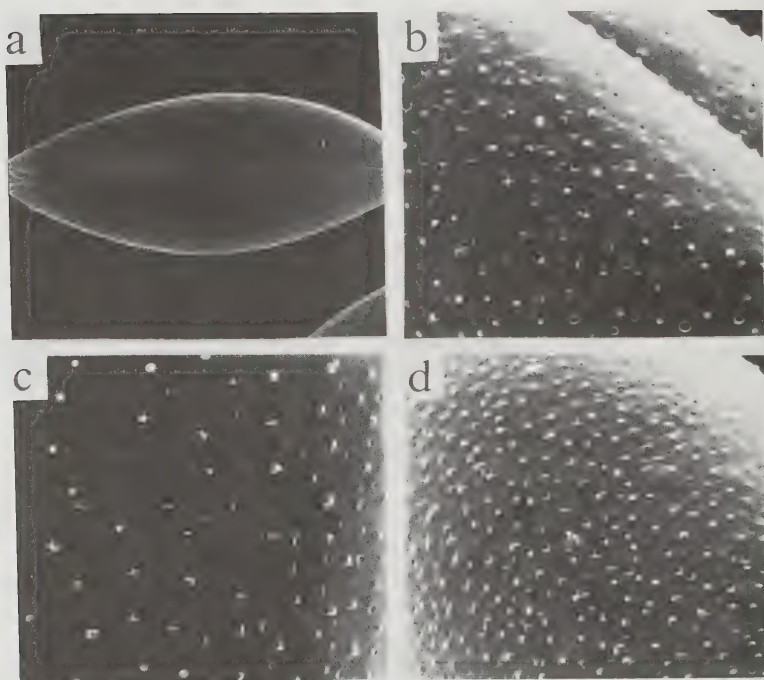


FIG. 2.

Scanning electron micrographs of pollen of *Tritonia* species: a, *T. pallida*, X 660; b, *T. deusta*; c, *T. crispa*; d, *T. lineata*; b-d X 2600.

numerous ovules on axile placentas, is shortly ellipsoid or somewhat truncate and about 2–4 mm in length.

The style is very slender and cream or off-white or sometimes pale pink or yellow especially towards the top when the flowers have those colours. The three style branches are short and slender and at first conduplicately folded. Their upper halves which constitute the three stigmas, usually flatten out to some extent when ripe. The tips are slightly widened and obtuse or sometimes slightly notched, and are minutely papillose on the edges.

**Capsule.** The capsules are membranous and in the majority of species they are shortly ellipsoid and somewhat trilobed or, when fewer seeds are set, obovoid or almost globose. In *T. dubia* and *T. laxifolia* they are elongated ellipsoid. They dehisce loculicidally starting from the top.

A large number of seeds usually ripen. These are 1.5–2 mm in diameter, are subglobose or angled by pressure, and usually shiny and brown or sometimes black. The testa is minutely reticulate-foveate or almost smooth, or sometimes colligulate (*T. lancea*). An elevated ridge is present on the raphe, running from the hilum to the micropylar region which is invariably darker brown or black.

#### CHROMOSOMES

Prior to Goldblatt's major work on the chromosome morphology of the Iridaceae (1971), only one species of *Tritonia* had been investigated cytologically (Brittingham, 1934; Sharma & Sharma, 1960). Goldblatt examined nine species of *Tritonia* and found the basic number to be 11 and all to be diploid except *T. lineata* which is tetraploid.

In the present investigation the chromosomes of ten species of *Tritonia* have been examined, five of which had not been examined before (Table 1).

TABLE 1

Chromosome numbers of species of *Tritonia* now investigated. First counts marked with an asterisk. Voucher specimens in STE.

Species	Diploid number	Collection data
Section <i>Tritonia</i>		
<i>T. crocata</i>	22	Riversdale Show Grounds, <i>De Vos</i> 2424
<i>T. squalida</i>	22	East of Riversdale, <i>De Vos</i> 2423
<i>T. deusta</i>	22	Riviersonderend–Caledon, <i>De Vos</i> 2429
<i>T. dubia</i>	22*	Bronnereservaat, Uitenhage, <i>Olivier</i> 2553
Section <i>Subcallosae</i>		
<i>T. pallida</i>	22*	Montagu, <i>De Vos</i> 2411
<i>T. bakeri</i>	22*	Hoekoe, Ladismith, <i>De Vos</i> 2414
<i>T. flabellifolia</i>	44*	Robertson–Bonnievale, <i>De Vos</i> 2437
<i>T. lineata</i>	44	Bronnereservaat, Uitenhage, <i>Olivier</i> 2603
Section <i>Montbretia</i>		
<i>T. chrysantha</i>	22*	Buffelsdrif–Bassau, Klein Karoo, <i>De Vos</i> 2419
<i>T. watermeyeri</i>	22	Allemorgens, Montagu, <i>Malan</i> 112

Goldblatt noted that the karyotype is undistinguished and similar for all the species he examined (except for the tetraploid *T. lineata*); that the chromosomes are fairly small (1.5–2.5  $\mu\text{m}$ ) and, although varying rather little in length, three pairs of slightly longer chromosomes could be recognised. The present investigation has shown similar results, except that another tetraploid, namely *T. flabellifolia*, has now been found. As Gold-

blatt had found this species to be diploid, it can be concluded that this species consists of diploid and tetraploid races. They cannot be distinguished morphologically. The tetraploid condition of *T. lineata* has now been confirmed. Both tetraploids belong to section *Subcallosae*. Sharma and Sharma's count of 60 for *T. crocata* could not be verified.

Species from four of the five sections of *Tritonia* have now been examined for their karyotype.

#### GEOGRAPHY AND ECOLOGY (Figs 3, 4, 9)

*Tritonia* species are widespread in southern Africa south of the equator, most occurring in the Republic of South Africa (R.S.A.) from its southernmost tip at S 34° 50' latitude to Namaqualand, throughout Natal, and Transvaal, and also in Lesotho and Swaziland; only three species occur to the north of the R.S.A., namely *T. nelsonii* in Malawi, *T. moggii* in Mozambique, and *T. laxifolia* in Zambia, Malawi, and Tanzania where it extends almost to the equator. A few species from Abyssinia, Eritrea and Reunion previously placed with *Tritonia*, belong to other genera. *T. mensensis*, for instance, is a *Gladiolus* species. The latest available data indicate that the genus is absent from South West Africa-Namibia, Angola and, apparently, Zimbabwe.

The majority of species are adapted to winter rainfall conditions, 16 species occurring in the Cape winter rainfall region which stretches from the Cape Peninsula eastwards to Port Elizabeth and includes the Little Karoo north of the first mountain ranges; and also stretches from the Cape Peninsula northwards to include Namaqualand where most of the rather intermittent rain also falls in winter.

The greatest concentration of species is in the southern coastal districts of this region, namely Caledon, Bredasdorp, Riversdale and Mossel Bay. Here eleven species have been found, belonging to four of the five sections into which the genus is now divided. West and northwest from this centre of development the number of winter rainfall species diminishes, only two species, namely *T. crispa* and *T. deusta* subsp. *miniata* occurring in the Cape Peninsula and south-western districts below the first mountain ranges. Northwards from this area five species have, however, been recorded: *T. crispa* ranges to Clanwilliam, and the closely related *T. lancea* occurs on Piketberg; farther north two species have been found in the Richtersveld of Namaqualand and another on the Kamiesberg.

Eastwards from the coastal developmental centre the winter rainfall species diminish to five in the Uitenhage-Port Elizabeth area.

A relatively small number of species are spread over the rest of Southern Africa and these are adapted to summer rainfall conditions. They sprout after spring or summer rains have fallen and flower in summer or autumn.

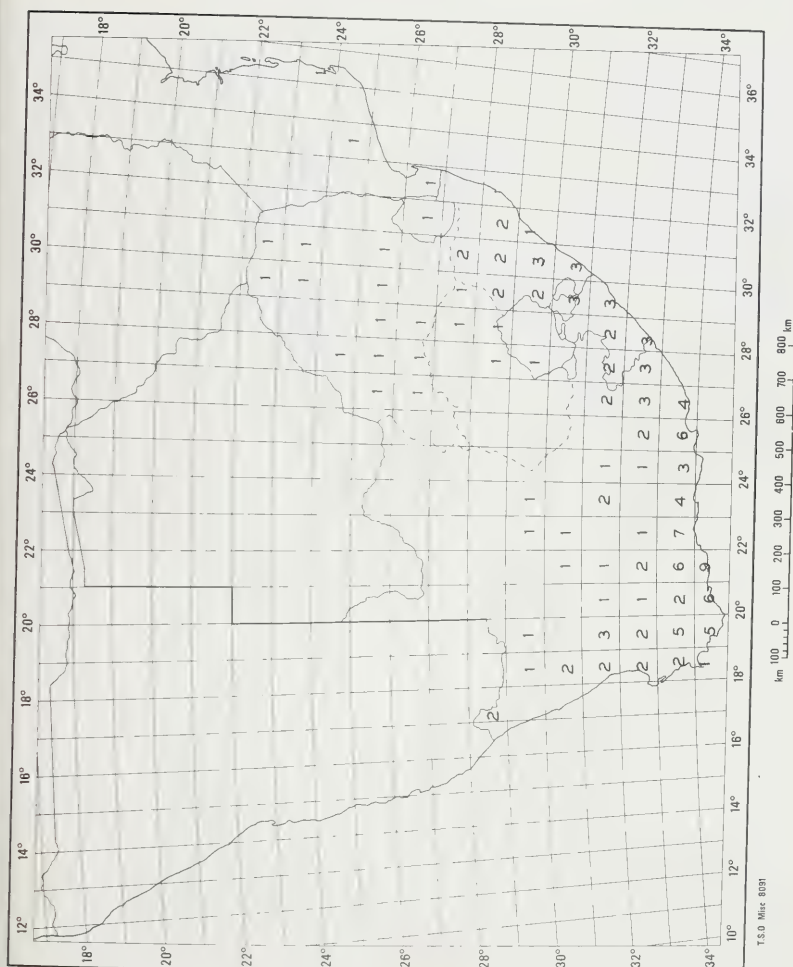


FIG. 3.  
Concentration of *Tritonia* species in Southern Africa.



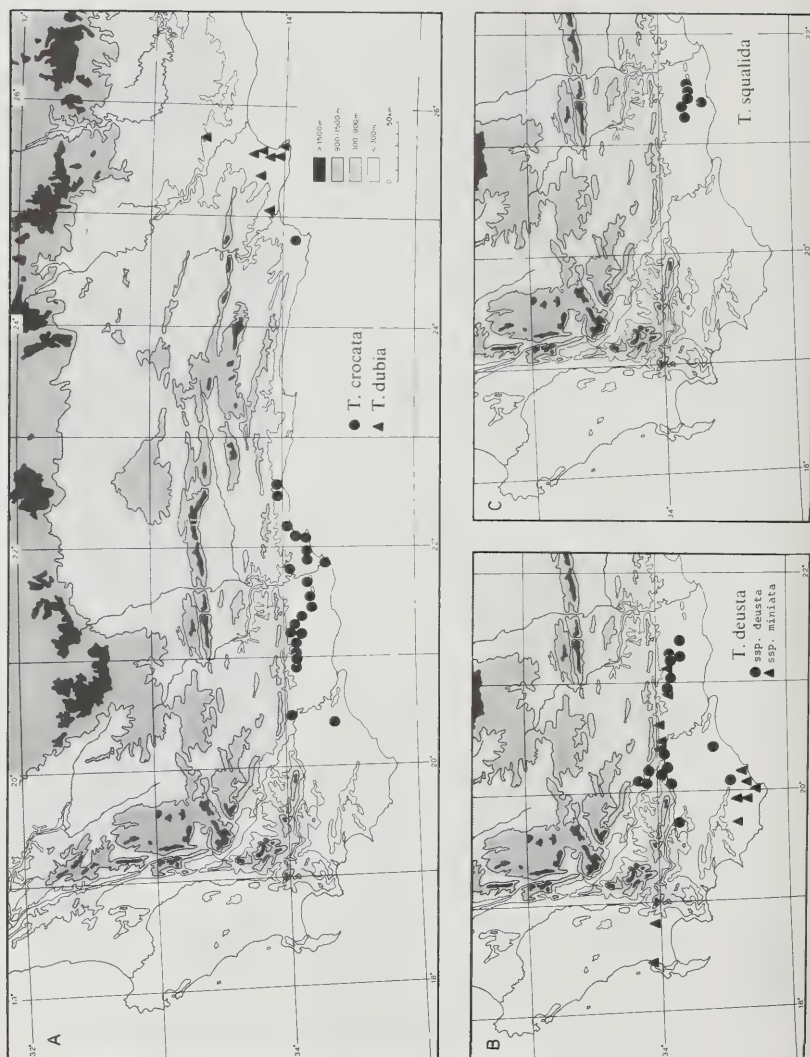


FIG. 4.

Geographical distribution of *Tritonia*, section *Tritonia*: A, *T. crocata* and *T. dubia*; B, *T. deusta*; C, *T. squalida*.

Three of these species are able to withstand the harsh conditions often prevailing in the Great Karoo where lengthy periods of severe drought of a year or longer occur all too often. These are *T. karooica* which has a wide distribution over the greater part of the western and central Karoo, and *T. tugwelliae* and *T. florentiae* from the southern parts of this region. They sprout after good rains and flower a month or two later.

Eight summer rainfall species have been recorded from the Eastern Cape Province, Natal, Transvaal and also Lesotho. *T. lineata* and *T. rubrolucens* have the widest range, from the Grahamstown area in the Eastern Cape, through Transkei and Natal, to south-eastern Transvaal and the Drakensberg mountain range, the former also extending into the eastern Orange Free State and the western part of Lesotho. *T. nelsonii* is widespread on the Highveld of Transvaal and *T. atrorubens* occurs in a small area in southern Transkei.

Outside the R.S.A. *T. moggii* occurs in the coastal regions of Mozambique and *T. laxifolia* is widespread in Malawi, Zambia and Tanzania. This species poses a problem: herbarium specimens from these regions can in no way be distinguished from *T. laxifolia* found in the Eastern Cape Province around Port Elizabeth and Grahamstown. These two areas are separated by a wide interval of about 1 800 km stretching through the Orange Free State, Transvaal and Zimbabwe where the species apparently does not occur.

Several species, from all five sections of the genus, are local endemics with small restricted ranges: *T. delpierrei* and *T. marlothii* in the Richtersveld and *T. kamisbergensis* on the southern Kamiesberg; *T. lancea* of Piketberg; *T. squalida* in a small area near Riversdale and Albertinia; *T. dubia* near Port Elizabeth and Uitenhage; *T. watermeyer* near Montagu and Barrydale; and *T. atrorubens* in southern Transkei.

*Tritonia* species grow on all types of geological strata and in all types of soil, from sandy soil and loam to gravelly, clayey or stony ground which often has very little humus.

The majority of species occur on plateaux or hillsides and flats, and a few, e.g. *T. crocata*, *T. deusta* and *T. squalida* are even found along roadsides. *T. moggii* is recorded from littoral sand at low altitude. *T. florentiae* has been found on a stony hillside in fissures between upright slate slabs. A few species occur on mountains: *T. kamisbergensis*, confined to the southern Kamiesberg, has corms deep-seated in rocky fissures of old Cape Granite. *T. lineata* grows on the Drakensberg range and also in Natal at low altitude. *T. nelsonii* is widely distributed on the Witwatersrand, the Highveld of Transvaal, and northwards almost to the Limpopo.

Most species grow in open sunshine. The corms are generally quite shallow at about 50–100 mm depth. They are nevertheless able to survive the intense heat generated in the dry summers of the winter rainfall region.

Possibly the extreme dryness of the summer in the south-western Cape is one of the reasons why only two species occur in this area. The southern coastal districts of this region, where the largest number of species is found, often receive some rain in summer.

Whether the three species in the Great Karoo are able to survive lengthy periods of severe drought of a year or longer by means of their corms, is uncertain. Possibly seeds stand a greater chance of survival.

#### HISTORICAL

Species of *Tritonia* became known in Europe and England during the eighteenth century. Linnaeus (1762) knew of only one species which he named *Ixia crocata*, and D. Delaroche (1766) described two species as *Ixia flabellifolia* and *I. iridifolia*, mentioning also that he had seen a variety of the latter with smaller flowers growing in the botanical garden at Leiden. N. L. Burman (1768) described *I. crocata* again and also *I. undulata*, a species which even today is incompletely known. Thunberg (1783) described in his *Dissertation* on *Ixia* two species which he had brought from the Cape, namely *I. crocata* and *I. lancea*; and in 1784 he described another two species under *Gladiolus*. In 1774 Masson had brought at least three species of *Tritonia* from the Cape to Kew gardens. These were described by Aiton (1789).

Aiton and Thunberg, as well as other workers of the eighteenth and early nineteenth centuries, such as Jacquin (1789a, b), Willdenow (1797) and Vahl (1805), placed those species of *Tritonia* with almost regular flowers with *Ixia*, and those with more zygomorphic flowers with *Gladiolus*.

The first figure that could be found of a *Tritonia* is in Miller's *Icones* (1758), of *T. crocata*, published with the polynym *Ixia planifolia caule multifloro spatha brevissima*. (The plant named *I. crocata* in Miller's *Dictionary* (1768) is, however, not a *Tritonia*.) Before the end of the century Jacquin (1789a) had figured four species and Andrews (1797) two species. Starting from 1792, a large number of species were figured in *Curtis's Botanical Magazine*; from 1802 under the newly described genus *Tritonia*, established by Ker-Gawler in that year.

Ker-Gawler (1802) stated that the genus differs from *Sparaxis* in the spathe not being partite-lacerated and the leaf axils not bearing bulbils; and from *Gladiolus* in the seeds not being winged. He omitted, then, to indicate in what way it differs from *Ixia*.

The genus *Tritonia* was at first recognised only by the British botanists Aiton (1810) and Harvey (1838), the latter stating that the genus approaches to *Gladiolus* on the one hand and to *Ixia* on the other, from both of which it differs by its scarious bracts. Workers on the continent, such as Vahl (1805), Willdenow (1809) and Roemer and Schultes (1817), kept the species

of *Tritonia* under *Ixia* and *Gladiolus*, and it was only after Klatt's major work in 1863 that the genus became generally recognised. Here the genus was subdivided into *Longicolles* with five species (three of which are incorrect for *Tritonia* and belong to other genera) and *Brevicolles* with nine species.

This slow recognition of the genus was perhaps due to Ker-Gawler's initial omission (1802) to state in what way it differs from *Ixia*. In 1805 he noted that the characters of the genus are very difficult to define and only in 1810 did he indicate that it differs from *Ixia* in its "staminibus nec stylum trifariam stipantibus tuboque in faucem dilatato". In 1827 however, he stated that the genus is distinguished from *Ixia* in its stamens inserted below the throat and almost always secund, corolla scarcely regular, segments always obtuse, retuse or subtruncate, and especially in its entirely different habit. Throughout the nineteenth century, starting with Ker-Gawler himself, there was no clear conception of the genus, and numerous species placed under *Tritonia* later were shown to belong to other genera. For example, three of the thirteen species listed under *Tritonia* by Ker-Gawler (1805) belong to genera such as *Ixia* and *Freesia*; and 14 of 32 species enumerated by Baker (1896) later had to be transferred to different genera, e.g. *Gladiolus*, *Watsonia*, *Hesperantha*, etc.

Furthermore, some authors considered the name *Tritonia* inadmissible as, according to Rafinesque (1832), there were already two genera to which that name had been applied (this could not be confirmed). Reichenbach (1828) published the name *Waitzia*, with *Tritonia*, "non Cuv. Zool." as only synonym, and Rafinesque, who in America evidently did not know of Reichenbach's new name for the genus, published the name *Belendenia* for it, a name that later was spelled *Bellendenia* (Schlechtendahl, 1833). Ecklon (1827) placed species of *Tritonia* under *Tritonia* and *Freesea*, the latter being a name not validly published.

In 1803 A. P. De Candolle established the genus *Montbretia* for the species *Gladiolus securiger* and *G. flavus* which differ from gladioli in their three "oreillettes calleuses perpendiculaires" on the upper faces of the three lower perianth segments. For more than a century taxonomists have differed about this genus. The majority, e.g. Ker-Gawler (1827), Bentham and Hooker (1883), N. E. Brown (1928), Diels (1930), Phillips (1951), considered it unnecessary and placed it as a section under *Tritonia*; others, namely Stapf (1924) and Sealy (1939-40), retained the genus. Baker and Klatt changed their ideas on the matter, Baker keeping *Montbretia* distinct in 1877 and combining it with *Tritonia* in 1892 and 1895; and Klatt doing likewise in 1882 and 1895. Endlicher (1836-40) on the other hand recognised only *Montbretia*, citing *Tritonia* as a synonym.

Today the name *Montbretia* is often used as a common name by horticult-

turalists for some species of *Crocoshmia* and for *Tritonia-Crocoshmia* hybrids (Eliovson, 1973).

The genus *Crocoshmia* was described by Planchon (1851–52) for *T. aurea* characterised by saffron coloured flowers with the throat of the perianth not dilated and with trilobed capsules containing only three seeds. Later several more species were added to the genus, chiefly from the eastern parts of South Africa and from Central Africa. At first Baker (1877) did not recognise the genus, but in 1892 and 1896 he restored it to generic level, after Bentham and Hooker had recognised it in 1883. Klatt also gave the genus a varied interpretation, in 1863 and 1895 keeping it as a separate genus, but in 1882 merging it with *Tritonia* as a section. Pax (1888) treated it as a section of *Tritonia* and Phillips (1951) also merged it in *Tritonia*. But Diels (1930), N. E. Brown (1932) and Goldblatt (1976) kept it distinct, although in a private communication Goldblatt expressed doubt whether there was sufficient reason to keep it separate.

Klatt (1882) described the genus *Tritonixia* for species of *Tritonia* characterised by an almost regular perianth with a short tube. Under section *Eutritonixia* he placed twelve species of *Tritonia*, including the type species of the latter genus. He also retained the genus *Tritonia* for species with almost regular flowers and a long perianth tube, including in this several species of *Tritonia* and *Ixia*, as well as a species of *Houttuynia* and of *Crocoshmia*. He also kept the genus *Montbretia* for those species with calli on the lower perianth segments, and thus separated species of *Tritonia* into three different genera. In 1895, however, he returned all, except four species, to *Tritonia*. These four species were transferred to *Tritonia* in the following year by Baker, and thus the genus *Tritonixia* went into synonymy.

Work on *Tritonia* in the twentieth century has been fragmentary. L. Bolus (1918, 1926, 1929) described a number of new species of which three are accepted in this revision. N. E. Brown, in an article on the Iridaceae in Thunberg's herbarium (1928), and another (1929) on the Iridaceae of Burman's *Prodromus Florae Capensis*, was able to clear up several important points about these old collections. It is, however, necessary to revise some of his statements. Foster (1936) realised that the names of some species of *Tritonia* were inadmissible being later homonyms, and instigated new names for these species.

Sealy (1939–40) tentatively suggested that, after species of *Montbretia* and *Dichone*, as well as other divergent species, had been removed, the remaining species of *Tritonia* could perhaps be split into three distinct genera. This suggestion was, however, not taken up by any worker and I do not consider it necessary.

In 1959 Lewis showed that a species of Baker's subgenus *Stenobasis*



(1896) is a *Tritoniopsis*, and in 1962 she transferred the three species of subgenus *Dichone* to *Ixia*.

The latest work on *Tritonia* is by Goldblatt (1971, 1974, 1976, the latter in Dyer's *Genera*). In 1971 he examined the chromosome morphology of the Iridaceae, including nine species of *Tritonia*, and concluded that this genus stands close to *Crocasmia* (including *Curtonus*) and *Chasmanthe*, thus bearing out Lewis's view (1954) that these genera are closely related. He placed the above-mentioned genera, as well as the monotypic *Montbretiopsis*, in a distinct subtribe *Tritoniineae*. Later (1974) he merged *Montbretiopsis* in *Tritonia*.

#### RELATIONSHIPS AND ORIGIN

*Tritonia* is closely related to *Crocasmia* and *Chasmanthe*, differing in its usually ellipsoid membranous or papery capsules with a large number of seeds, and from the latter also in its funnel-shaped perianth tube which widens gradually in the upper portion. It is also related, perhaps less closely, to *Ixia* from which it is sometimes difficult to distinguish. It differs from this genus in its mostly zygomorphic or sometimes almost regular flowers, with the stamens and style curved and often laterally displaced or randomly curved, and leaves generally without a strong strand of sclerenchyma in the leaf margins. One species, *T. dubia*, has regular flowers and connects the two genera.

The above-mentioned genera belong to the subfamily Ixioidae which Pax (1888) subdivided into three tribes, namely *Gladioleae*, *Ixieae* and *Watsonieae*, with *Tritonia* (including *Crocasmia*), and *Gladiolus*, etc. in the first mentioned tribe and *Ixia* in the second. Hutchinson (1959) likewise placed *Tritonia* and *Crocasmia* in tribe *Gladioleae*, and *Ixia* in tribe *Ixieae* together with *Dierama*, etc. Diels (1930) on the other hand followed Bentham and Hooker (1883) and did not subdivide the tribe *Ixieae* (sensu lato as established by Bentham and Hooker as the equivalent of Pax's subfamily Ixioidae); but Lewis (1954), after a detailed morphological study of the family, was able to subdivide this group with greater success than Pax had done, into six subtribes, the largest of which is the *Ixiineae* comprising amongst others, all the above-mentioned genera. She did not divide this group further into more subtribes as it would have resulted "in an artificial grouping of the genera based entirely on the symmetry of the flowers" (Lewis, 1954).

Goldblatt (1971), with the use of the chromosome morphology as an additional criterion, divided the *Ixiineae* of Lewis into four subtribes, namely *Hesperanthineae*, *Gladiolineae*, *Ixiineae* in a narrower sense comprising only the genera *Dierama*, *Ixia*, *Sparaxis* and *Synnotia*, and the *Tritoniineae* with *Tritonia*, *Crocasmia* (including *Curtonus*), *Chasmanthe*, *Zygotropia*

and *Montbretiopsis*. In my opinion the evidence that places *Tritonia* and its allies apart from the *Ixiineae* in a subtribe of their own, is insufficient. According to Goldblatt *Tritonia* and its allies have a rather different karyotype from that of *Ixia* and its allies; but the idiograms of *Tritonia*, *Crocasmia* and *Chasmanthe* figured by Goldblatt do not seem to differ much from those of *Ixia*, *Dierama* and *Sparaxis*, except for the extra chromosome in the haploid complement of *Tritonia* and *Crocasmia* (11 versus 10). (*Chasmanthe* also has ten as in *Ixia*.) This, together with morphological data such as membranous bracts and almost regular flowers in some species of *Tritonia*, suggests that the two subtribes in question should again be united.

Goldblatt's suggestion (1971) is probably correct that *Crocasmia*, which comprises large plants occurring in the eastern parts of southern and central Africa, could have given rise to *Tritonia* and *Chasmanthe*. He further suggested that *Ixia* evolved from *Dierama* in response to the more exacting ecological conditions in the western Cape Province. *Dierama* which has a wide distribution from tropical Africa southwards to the Eastern Cape Province, is a more primitive genus with some unspecialised characters such as its mostly evergreen habit, large persistent corm and regular flowers. *Tritonia* and its allies are probably also derived from a *Dierama*-like ancestor, their specific features having been developed in the course of their migration to southern Africa where different climatic conditions occur.

The monotypic genus *Montbretiopsis* which was merged in *Tritonia* by Goldblatt (1974) differs from the latter in its short, almost subterranean scape and specialised inflorescence with few flowers each on a terminal peduncle. It belongs to section *Montbretia* of *Tritonia* on account of its perianth with large calli. It is the most highly specialised species in the genus.

A fifth genus mentioned with *Tritonia*, namely *Zygotritonia*, is a small tropical African genus described by Mildbraed (1923) to harbour *Tritonia bongensis* and two other species. This genus shows characters which make it difficult to believe that it is related to either *Tritonia* or *Crocasmia*, such as an undivided "hochstens schwach gelappte, aber nicht in deutliche Narbenäste getrennte Griffel" and bilabiate perianth with five clawed tepals forming a sort of lower lip, and few basal ovules (Mildbraed, 1923). The leaf structure is also different (De Vos, 1982).

#### SUBGENERIC GROUPING OF THE SPECIES

Baker's subgeneric delimitation of 1892 and 1896 differs widely from that of 1877. With the data at present available neither is acceptable.

In 1877 he kept *Montbretia* separate, widening its circumscription to include species with calli and others with only blotches on the lower perianth

segments. He subdivided *Tritonia* into three sections, namely *Eutritonia*, *Dichone* and *Crocospia*, the first mentioned containing as it should, the type species of the genus. Pax's grouping (1888) was essentially similar, except that he incorporated *Montbretia* with *Tritonia* as a fourth section.

In 1892 and 1896 Baker also placed *Montbretia* with *Tritonia*, returning to it its original De Candolleian circumscription. He subdivided *Tritonia* into five subgenera, namely *Tritonixia*, *Dichone*, *Tritonia Proper* (*Eutritonia*), *Montbretia* and *Stenobasis*. *Crocospia* was raised to generic level. For some reason he changed the circumscription of *Tritonia Proper* so that it no longer contained the type species of the genus—this was relegated to subgenus *Tritonixia* which Klatt (1882) had established as genus for species of *Tritonia* with an almost regular perianth. Diels (1930) largely followed Baker's treatment of 1896.

Of the above-mentioned subgenera only two, *Montbretia* and *Tritonixia*, consist of well-defined groups of species. Subgenus *Dichone* was transferred to *Ixia* by Lewis (1962), a decision which was later endorsed by Goldblatt (1971). Subgenus *Stenobasis* is cancelled, as its two species and a hybrid belong to other genera. Subgenus *Tritonia Proper* contains twenty largely unrelated species, ten of which have already been transferred to other genera; and the remaining species are not closely related.

Both Stapf (1924) and Sealy (1939–40) realised the inadequacy of Baker's delimitations and advocated a radical regrouping of the species of *Tritonia*. They proposed that *Montbretia* and *Dichone* should again be given generic rank, and Sealy further proposed that after these groups, as well as those species which belong to diverse other genera, had been removed from *Tritonia*, the remaining 16 species fall into three well-marked groups which could even be accorded generic rank. Only one of his groups, however, that with short-tubed, widely expanded, almost rotate perianth, comprising *T. crocata*, *T. deusta* and *T. squalida*, is homogeneous. He placed too great an importance on the length of the perianth tube, and each of his other two groups, one with long-tubed perianth and the other with a short-tubed, more or less funnel-shaped perianth, contains heterogeneous elements.

The present subgeneric division in which five sections are recognised, is based on floral and leaf morphology and to some extent on leaf anatomy. Less importance is given to the length of the perianth tube. (Lewis also found (1954) that in several other Iridaceous genera the length of the perianth tube is often of relatively little importance.) The chromosome morphology did not contribute anything, on account of the similarity of the karyotypes of the species investigated.

It has not been found necessary to divide *Tritonia* into separate genera, as Stapf (1924) and Sealy (1939–40) tentatively suggested. *Montbretia* with

its large well-developed calli, is again incorporated with *Tritonia* as a section. Several intermediates with small undeveloped calli on one or more of the anticonic perianth segments indicate the close relationship of these two taxa. A new section, *Subcallosae*, is therefore established to house the species with zygomorphic flowers, some with small calli and others without any.

Section *Pectinatae* differs from section *Subcallosae* in its scape which is curved below the spike to give the latter an almost pectinate appearance, and in its divergent leaf structure.

Section *Teretifoliae* with a single species *T. kamisbergensis*, is distinguished by its wiry subterete leaves and the absence of calli.

Sealy's group of species with short perianth tube and spreading, almost rotate limb, is section *Tritonia*, as it contains the type species of the genus. *T. dubia* is added to this section.

*Tritonia* is one of the highly specialised genera of the Ixioidae. Section *Subcallosae* which of the five sections has the second widest distribution in both summer and winter rainfall areas, is considered to be the most primitive of the genus and probably diverged into the other sections, three of which are, with the exception of one species, namely *T. tugwelliae*, confined to the winter rainfall region of the Cape. The almost regular flower of section *Tritonia* is probably specialised, having evolved from a zygomorphic condition.

#### TAXONOMY

***Tritonia*** Ker-Gawl. in Curtis's Bot. Mag. **11** t. 581 (1802) & sub t. 1275 (1810) & in Kon. & Sims, Ann. Bot. **1**: 227 (1805) partly, & Irid. Gen. 113 (1827), excl. syn. *Houttuynia*, *Hexaglottis*, *Sisyrinchium*; Klatt in Linnaea **32**: 755 (1863) & in Abh. Naturf. Ges. Halle **15**: 357 (1882) excl. syn. *Houttuynia*; Benth. in Benth. & Hook. f. Gen. Pl. **3**: 708 (1883); Bak. in J. Linn. Soc. **16**: 161 (1877) excl. sect. *Dichone* & *Crocasma*, & Handb. Irid. 190 (1892) excl. subgen. *Dichone* & *Stenobasis*, & in Fl. Cap. **6**: 118 (1896) excl. subgen. *Dichone* & *Stenobasis*; Pax in Nat. Pflanzenfam. **2** (5): 155 (1888), excl. sect. *Dichone* & *Crocasma*; Stapf in Curtis's Bot. Mag. sub t. 9038 (1925); Diels in Nat. Pflanzenfam. ed. 2, **15a**: 490 (1930) excl. sect. *Dichone* & *Stenobasis*; N.E.Br. in Trans. Roy. Soc. S. Afr. **20**: 264 (1932) sub *Crocasmia*; Foster in Contr. Gray Herb. **114**: 44 (1936); Sealy in Curtis's Bot. Mag. sub. t. 9592 (1939-40); Lewis in Adams. & Salter, Fl. Cape Penins. 249 (1950) excl. *T. scillaris*; Phillips, Gen. S. Afr. Flow. Pl. ed. 2: 218 (1951) excl. syn. *Crocasmia*; Goldbl. in J1 S. Afr. Bot. **37**: 423 (1971) & in Dyer, Gen. S. Afr. Flow. Pl. 972 (1976).

*Type species: T. squalida* (Ait.) Ker-Gawl. (see under *T. squalida*).

*Montbretia* DC. in Bull. Sci. Soc. Philom. **3**: 151 (1803); Voigt, Hort.

Suburb. Calc. 610 (1845); Klatt in *Linnaea* **32**: 752 (1863); Bak. in *J. Linn. Soc. Bot.* **16**: 167 (1877); Stapf in *Curtis's Bot. Mag.* sub t. 9038 (1924). Type species: *M. securigera* (Ait.) DC.

*Waitzia* Reichb. *Consp.* 60 (1828), nom illeg.; non Wendl. (1808 *Compositae*).

*Belendenia* Raf. in *London Gard. Mag.* **8**: 245 (1832). Type species: as for *Tritonia*.

*Bellendenia* Schlechtd. in *Linnaea* **8** Lit. Ber. 68 (1833), orth. var. pro *Belendenia*.

*Tritonixia* Klatt in *Abh. Naturf. Ges. Halle* **15**: 355 (1882), excl. syn. *Dichone & Agretta*. Type: as for *Tritonia* (lecto-).

*Montbretiopsis* L. Bol. in *S. Afr. Gard.* **19**: 215 (1929); Phillips, *Gen. S. Afr. Flow. Pl.* 219 (1951); Goldbl. in *Bothalia* **11**: 281 (1974), pro syn. Type species: *M. florentiae* (Marl.) L. Bol.

*Freesea* Eckl. *Top. Verz.* 30 (1827), non rite publ.

Plants small to medium, deciduous. *Corm* small, globose to ovoid, sometimes depressed or vertically elongated, with tunics of fine or somewhat coarser reticulate and subparallel fibres. *Scape* well developed, erect, simple or with few branches, sometimes with a collar of old leaf bases around its base, or rarely short and barely extending above-ground. *Leaves* several, basal, distichous, erect to spreading, ensiform-unifacial, falcate or lanceolate-linear, rarely subterete or H-shaped in cross section, glabrous, acuminate to subobtusate, rarely minutely ciliate on the margins; cauline leaves few, small, subulate, somewhat bract-like, largely bifacial. *Spike* simple or with few branches from below its base, secund or sometimes somewhat distichous, with few to numerous flowers, rarely reduced to one. *Bracts* membranous, usually becoming scarious, brown, often sphacelate towards the tip, veined; outer 3-toothed with acute teeth, or sometimes acuminate or 5-toothed or irregularly toothed; inner equal to or slightly smaller than the outer, bidentate or shortly bifid, 2-veined, sometimes with wide papery margins. *Flowers* zygomorphic or almost regular, suberect or spreading, cream, yellow, orange, orangy-red or pink. *Perianth tube* short, funnel-shaped, or long, tubular and widening gradually near the top; *segments* subequal or unequal, the posticous segment often largest, erect and hood-like, other segments then spreading; three anticus segments often bearing an axe-like callosus near their bases, often with coloured honey-guides. *Stamens* inserted in the perianth tube where it widens, often asymmetrically arranged; *filaments* often curved towards the posticous segment, or curved randomly; *anthers* linear, often contiguous, placed towards the posticous segment and facing the anticus side, pale or violet. *Ovary* 3-chambered with numerous ovules,



shortly ellipsoid; *style* long, slender, often curved, with three short, spreading or recurved stigmatic branches. *Capsules* ellipsoid to obovoid, membranous; *seeds* numerous, small, globose or angled by pressure, with a usually brown, shiny, reticulate-foveate testa. *Chromosome numbers*  $2n = 22$ , rarely 44.

The genus differs from *Crocsmia* in its membranous, many-seeded, usually ellipsoid capsules; from *Chasmanthe* in its gradually widened perianth tube and many-seeded, usually ellipsoid capsules; from *Ixia* in its mostly zygomorphic flowers usually in a secund or almost secund arrangement, with irregularly spreading or unilateral stamens, and leaves without a fibre strand in the leaf margins; from *Sparaxis* in its non-lacerated bracts and usually zygomorphic flowers; and from *Gladiolus* in its scarious bracts and wingless seeds.

#### KEY TO THE SECTIONS

1. Flowers almost regular (rarely completely regular) with spreading segments; stamens randomly curved (rarely erect), with anthers not contiguous and not all facing the anterior side of the flower:
  2. Leaves lanceolate, ensiform, flat; perianth tube shorter than, or sometimes subequal to the segments ..... 1. Sect. **Tritonia**
  2. Leaves linear, somewhat thickened (fresh) and striate (dry); perianth tube longer than the segments ..... 4. Sect. **Subcallosae**
1. Flowers zygomorphic, with the posterior segment widest and suberect; stamens curved towards the posterior segment, with anthers contiguous and facing the anterior side of the flower:
  3. Spike dense, curved slightly below its base to give it an almost pectinate appearance; flowers white, cream or pale pink with reddish honey-guides in the throat; leaves with crisped-undulate or inrolled margins or with four longitudinal ribs or flanges ..... 2. Sect. **Pectinatae**
  3. Spike lax or sometimes dense, erect or suberect, secund or somewhat distichous, not pectinate; flowers red, orange, yellow, or sometimes pale, often with a yellow honey-guide and sometimes a callus on the lower segments; leaves lanceolate, ensiform, with entire margins, rarely undulate or filiform:
    4. Leaves filiform, terete or subterete, wiry, striate when dry ..... 3. Sect. **Teretifoliae**
    4. Leaves lanceolate, ensiform, rarely spirally twisted with undulate margins:
      5. Perianth with a high callus on each, or sometimes only the median, anterior perianth segment ..... 5. Sect. **Montbretia**
      5. Perianth without calli, sometimes with a low medianly elongated ridge in the throat on one or all three anterior perianth segments ..... 4. Sect. **Subcallosae**

KEY TO SECTION *TRITONIA*

1. Flowers regular; perianth tube slightly shorter than the segments; stamens erect ..... 4. *T. dubia*
1. Flowers almost regular; perianth tube about half or less than half the length of the segments; stamens curved irregularly:
  2. Claws of the perianth with wide hyaline margins; perianth tube with hardly any yellow colouring in its base:
    3. Perianth pale pink to bright mauvish pink, drying to a dirty (squalid) mauve ..... 1. *T. squalida*
    3. Perianth bright orange-red or pinkish-orange (vermilion).... 2. *T. crocata*
  2. Claws of the perianth without hyaline margins; perianth tube inside with a small yellow star-shaped base when fresh:
    4. Flowers with a reddish-black blotch on the outer perianth segments, rarely also on one or more of the inner segments ..... 3. *T. deusta* subsp. *deusta*
    4. Flowers without dark blotches, sometimes with a yellow blotch or rarely a small dark spot on the median anterior segment ..... 3. *T. deusta* subsp. *miniata*

KEY TO SECTION *PECTINATAE*

1. Leaf margins undulate and/or crisped:
  2. Bracts with dark reddish-brown upper margins; flowers longer than 40 mm, with perianth segments longer than 12 mm ..... 5. *T. crispa*
  2. Bracts with pale upper margins; flowers 32–40 mm long, with perianth segments 7–9 mm long ..... 8. *T. tugwelliae*
1. Leaf margins smooth, entire:
  3. Leaves narrow, filiform, channelled, or wider and with four longitudinal ridges or flanges (H-shaped in cross section) ..... 7. *T. cooperi*
  3. Leaves linear-lanceolate with inrolled margins, often narrowed between the sheath and lamina into a petiolar middle portion ..... 6. *T. lancea*

SECTION *TERETIFOLIAE* has a single species, *T. kamisbergensis*.

Section *TRITONIA*

Sect. *Eutritonia* Bak. in J. Linn. Soc. **16**: 162 (1877).

Subgen. *Tritonixia* (Klatt) Bak. Handb. Irid. 190 (1892) & in Fl. Cap. **6**: 118 (1896).

*Tritonixia* Klatt sect. *Eutritonixia* Klatt in Abh. Naturf. Ges. Halle **15**: 356 (1882) partly.

Type species: *T. squalida* (Ait.) Ker-Gawler

*Leaves* lanceolate-ensiform, usually spreading fan-wise. *Perianth* almost regular or in one species completely regular, widely cup-shaped, orange to orange-red or pink, often with a small yellow base, variously marked with yellow or reddish-black blotches or lines on the claws, sometimes with a low callus on some blotches; *tube* usually short, with its narrow lower half often slightly curved and twisted, thus inverting the flower partially or wholly; *segments* subequal, obovate-spathulate, clawed, or elliptical, longer than the tube, the inner segments a few millimetres wider than the outer and the

posticous segment often about a millimetre wider than any other segment. *Stamens* and *style* at first often curved towards the posticous segment with the anthers facing the opposite side, but later curved randomly, rarely erect.

Distribution: In the winter rainfall region of the Cape Province, mostly in the southern coastal districts from Mossel Bay to Caledon, with outliers to the Cape Peninsula, the Little Karoo and one species in the Port Elizabeth area (Fig. 4).

Three species of this section, collectively known as "Mossel Bay Kalkoentjies", are sympatric and closely related and are distinguished by only minor characters of the perianth such as colouring and markings, and the presence or absence of hyaline zones on the claw margins. They were formerly described as five distinct species, but the two species, *T. crocata* and *T. hyalina*, proved to be conspecific; and two other species, namely *T. deusta* and *T. miniata*, are linked by a continuous series of intermediates and are so closely related that they are now treated as a single species. Many of the older collections in which the flower colouring and markings have faded, or where the bases of the claws are not clearly shown, cannot be identified correctly.

The fourth species here included, namely *T. dubia*, occurs in the Port Elizabeth district in the eastern extremity of the winter rainfall area. It differs in its completely regular perianth.

The inverted position of the flower where the posterior tepal is lateral or on the anterior side, is a constant feature of the three "kalkoentjie" species.

Low calli, hardly 1 mm in height, occur in *T. crocata* and *T. deusta* subsp. *miniata* on the yellow stripe of one, or all three, anticus perianth segments. These calli which are yellow and elongated in the median line of the claw, are difficult to recognise in herbarium specimens. In *T. deusta* subsp. *deusta* a reddish-black callus occurs on the dark blotch of the outer perianth segments.

1. *Tritonia squalida* (Ait.) Ker-Gawler in Curtis's Bot. Mag. **16** t. 581 (1802), excl. syn. *Ixia lancea*, & in Kon. & Sims, Ann. Bot. **1**: 228 (1805); Ait. Hort. Kew ed. 2, **1**: 92 (1810); Bak. in J. Linn. Soc. **16**: 163 (1877), excl. syn. *I. lancea*, & Handb. Irid. 91 (1892), & in Fl. Cap. **6**: 119 (1896); Klatt in Dur. & Schinz, Consp. Fl. Afr. **5**: 207 (1895), Goldbl. in Flow. Pl. Afr. 42 t. 1676 (1956).

*Ixia squalida* Ait. var. ( $\alpha$ ) *patula* Ait. Hort. Kew. **1**: 61 (1789); Gmel. Syst. Nat. **2**: 109 (1796); Willd. Sp. Pl. ed. 4, **1**: 206 (1797); non Thunb. (1803). Type: Prom. bon. Spei, Masson (BM, holo-).

*Tritonixia squalida* (Ait.) Klatt in Abh. Naturf. Ges. Halle **15**: 356 (1882).

*Ixia similis* Salisb. Prodr. 38 (1796), nom. superfl. (excl. syn. *I. hyalina*).  
Icones: Curtis's Bot. Mag. t. 581 (1802); Red. Lil. 2 t. 87, sub *Ixia hyalina*;  
Jacq. Fragm. t. 32 f.2, sub *I. fenestrata* var.; Flow. Pl. Afr. 42 t. 1656;  
this work **Fig. 5**.

*Plants* (200–)250–400(–500) mm long. *Corm* ovoid to subglobose, 15–30 mm diam.; tunic fibres fine, reticulate, subparallel at the base. *Scape* (200–)250–400(–500) mm long, suberect or slightly flexuose, simple or with 1–2 branches, sometimes with old leaf bases 20–30 mm long around the base. *Leaves* 4–8, distichous, lanceolate-ensiform, erect to curved and spreading, (50–)70–200(–300) × 4–10 (–15) mm, acute, sometimes subobtuse, finely striate with a prominent middle vein, sometimes reaching up to the base of the spike; cauline leaf narrower, acuminate, to 80 mm long. *Spike* secund or sometimes somewhat distichous, with (2–)6–10 or rarely more flowers. *Bracts* largely membranous, sometimes greenish towards the base, brown and/or densely speckled in the upper part, and with brown upper margins, (8–)10–16 mm long; *outer* obtuse or 3-toothed, striate with a prominent median vein, sometimes keeled and with the median tooth shorter than the lateral ones; *inner* bidentate, with two veins, equal to or slightly shorter than the outer. *Flowers* almost regular, widely cup-shaped, (30–)35–40(–48) mm long, deep mauvish-pink to pale pink or almost white (RHS 56A-C, 55C, D, 64C, D), often with deeper pink or purplish veins, often deeper pink or yellowish in the base, the anticus segments sometimes with a pale yellow or deep pink median line in the throat. *Perianth tube* (8–)12–15 mm long, curved in its narrow lower half, widening to 7–10 mm diam. in the upper portion; *segments* subequal, spreading, rhomboid-spathulate to obovate-spathulate, obtuse or sometimes minutely emarginate, (16–)20–28 × (8–)10–17 mm, the claws with wide hyaline marginal zones. *Stamens* irregularly curved; *filaments* 8–12 mm long, often pink in the upper half; *anthers* 5–8 mm, pale or purple, curved, reaching less than halfway up the perianth, with pale yellow or mauve pollen. *Ovary* 2.5–4 mm long; *style* 15–20 mm long, pale; *stigmatic branches* 5–6 mm long, reaching the anther tips or overtopping them. *Capsules* shortly ellipsoid or obovoid-trigonus; seeds brown, smooth, 2 mm diam. *Chromosome number*  $2n = 22$ .

Flowering period: late September to late October.

Distribution: Cape southern coastal districts in a small area from Albertinia to Riversdale and to Stilbaai (Fig. 4C).

CAPE—3421 (Riversdale): Betw. Little Brak River and Riversdale, *Van Eeden* NBG 3026/32; S of Riversdale on Blombos road (-AA), *Lewis* 5632 (NBG), *Goldblatt* 5090 (MO); W of Albertinia (-AB), *Barker* 8222 (NBG), *Lewis* 5567 (NBG), *Goldblatt* 4153 (MO); Between Albertinia and Riversdale, *Lewis* 3650 (SAM); 8 mls

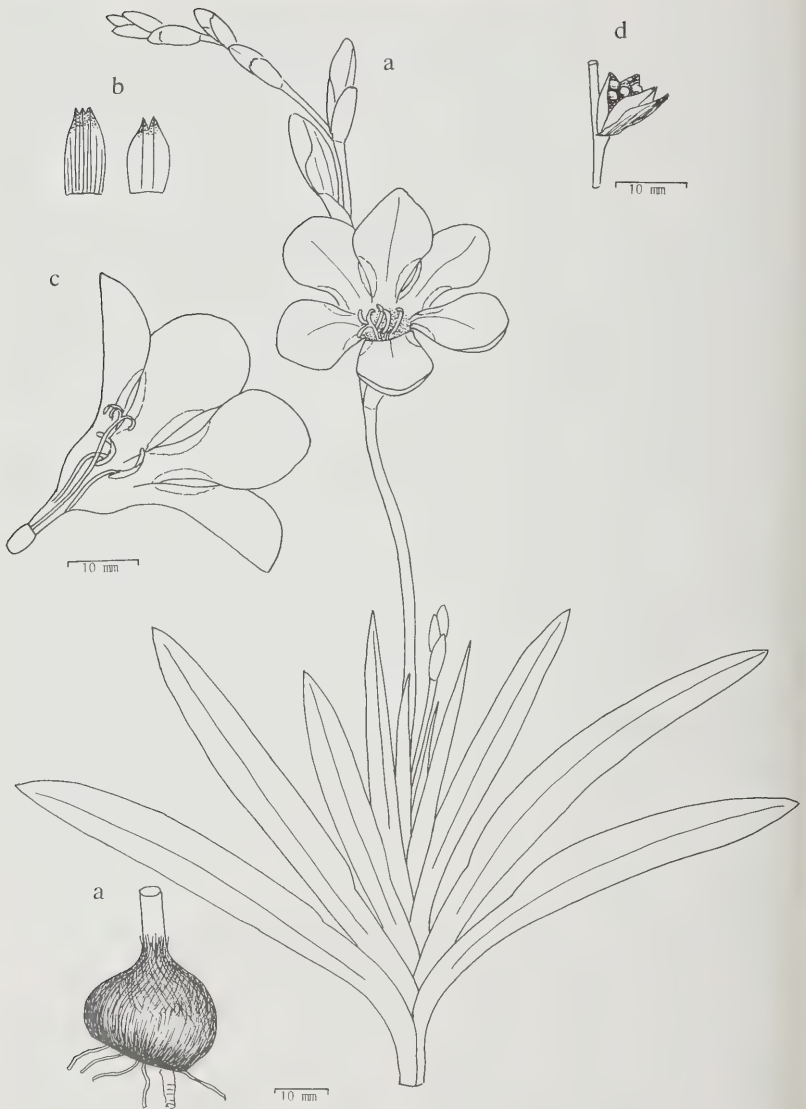


FIG. 5.

*Tritonia squalida* (De Vos 2423): a, plant; b, outer (left) and inner (right) bract; c, flower half in a median section; d, dehiscent capsule.



from Riversdale, Van Breda 730 (PRE), De Vos 2423 (STE), Mauve 4582 (PRE); Near Melkhoutfontein (-AD), Galpin 4711 (PRE); Albertinia (-BA), Bayliss 2419 (NBG), Muir 1090 (BOL), Admiraal 170 (PRE).

Without precise locality: SAM 21204; Pappe SAM 48512 (SAM), 1833 (S); Pappe s.n. (K); Thom s.n. (K); Ecklon (S); MacOwan 345 (K); Drège Irid. 278 (G); Verreaux ann. 1831 (G); sub *T. fenestrata*, *Ixia fenestrata*, *I. fenestralis*, etc. (L).

This species is closely related to *T. crocata* which has a perianth with similar hyaline marginal zones on the claws. It differs from the latter mainly in its flower colouring and according to Ker-Gawler (1802) in being scented—the latter feature could not now be verified. In dried specimens the flower colour fades to a rather dirty mauve, hence the name. Fresh specimens are certainly not squalid.

Jacquín (1809) considered *T. squalida* and *T. crocata* to be conspecific, describing and figuring the latter as *Ixia fenestrata* (1790) and the former as a variety of this (1809). The type of *I. similis* Salisb. could not be found, but it appears that Salisbury (1796) also included both species under this name. He gave no indication of the flower colouring and cited both species as synonyms.

On the other hand Aiton (1789) described them as separate species and Ker-Gawler (1802), Baker (1896) and Klatt (1882) followed him in this. In the present work they are also treated as distinct species, as even old herbarium specimens are readily distinguishable and as no specimens have as yet been found in natural populations which can be distinguished as intermediates. In South African gardens, however, *Tritonias* occur with a bright vermilion pink colour which might perhaps have originated as garden hybrids between these two species. Plants with a similar colouration have not been found in nature.

Natural putative hybrids between *T. squalida* and *T. deusta* have been collected near Albertinia (Bayliss 2420 in NBG).

According to the *Index Nominum Genericum* (1979) the name *T. squalida* is illegitimate, the reason probably being that Ker-Gawler cited *Ixia lancea* Thunberg as a synonym when he made the combination in 1802. He was, however, uncertain about this, as he placed no less than five question marks, one after each of the literature references he cited with *I. lancea*. He also observed that "we have not adopted Thunberg's trivial name of *lancea*, for although, taking circumstances together, we have little doubt but this is his plant, yet the description is far too vague to apply with certainty to any species". (If he had seen Thunberg's type he would without any doubt have realized that *I. lancea* is a totally different species—cf Fig. 12). But as he was uncertain about the matter, it can be concluded that Article 63 of the *International Code of Botanical Nomenclature* does not apply in this case and that the name *T. squalida* can be regarded as legitimate. (Ker-Gawler also

correctly cited as synonyms a variety of *Ixia crocata* of Burman, Prodr., as well as *I. similis* Salisbury, a later synonym.)

2. *Tritonia crocata* (L.) Ker-Gawler in Curtis's Bot. Mag. sub t. 581 (1802) & in Kon. & Sims, Ann. Bot. **1**: 228 (1805); Klatt in Linnaea **32**: 763 (1863) & in Dur. & Schinz, Consp. Fl. Afr. **5**: 204 (1895); Bak. in J. Linn. Soc. **16**: 162 (1877) & Handb. Irid. 190 (1892) pro parte, & in Fl. Cap. **6**: 119 (1896) excl. var. *miniata*; non sensu Goldblatt in Flow. Pl. Afr. sub t. 1655 (1972).

*Ixia crocata* L. Sp. Pl. ed 2, **1**: 52 (1762), excl. cit. Miller; & Syst. Nat. ed 12, p. 75 (1767); Burman f. Fl. Cap. Prodr. **1** (1768); Thunb. Diss. Ixia 17 (1783) excl. var. a; Aiton, Hort. Kew. **1**: 60 (1789); Curtis, Bot. Mag. t. 184 (1791); non Miller, Gard. Dict. ed. 8 (1768). Type: Cape, s. coll. (LINN, holo-).

*Gladiolus crocatus* (L.) Pers. Syn. Pl. **1**: 44 (1805).

*Tritonixia crocata* (L.) Klatt in Abh. Naturf. Ges. Halle **15**: 355 (1882).

*Ixia iridifolia* Delaroché, Descr. Pl. Aliq. Nov. 24 (1766); Goldblatt & Barnard, in J. S. Afr. Bot. **36**: 310 (1970). Type: sub *I. crocata* (Hb. Van-Royen, L. neo-).

*I. hyalina* L.f. Suppl. 91 (1781); non DC. in Red. Lil. t. 87 (1805). Type not found. The description may be regarded as type (Art. 9.3).

*Tritonia hyalina* (L.f.) Bak. in J. Linn. Soc. **16**: 163 (1877) & Handb. Irid. 191 (1892) & in Fl. Cap. **6**: 119 (1896); Klatt in Dur. & Schinz, Consp. Fl. Afr. **5**: 205 (1895).

*Tritonixia hyalina* (L.f.) Klatt in Abh. Naturf. Ges. Halle **15**: 356 (1882).

*Ixia fenestrata* Jacq. Coll. **3**: 270 (1789) & Ic. t. 289 (1790), lecto-type; non Thunb. (1803, 1811), nec. Jacq. (1809).

*Belemcanda fenestrata* Moench, Meth. 529 (1794).

*Tritonia fenestrata* (Jacq.) Ker-Gawl. in Curtis's Bot. Mag. 19 t. 704 (1804) & in Kon. & Sims, Ann. Bot. **1**: 228 (1805); Klatt in Linnaea **32**: 762 (1863).

*Ixia similis* Salisb. Prodr. 38 (1796) nom. superfl. (excl. syn. *I. squalida* var.).

*I. planifolia caule multifloro* Miller, Ic. 160 & t. 239 f.2 (1758).

*Tritonia sanguinea* Eckl. Top. Verz. 29 (1827). Type: Ecklon, E.H.B. Oct. 14-26 (S, holo-).

Icones: Miller, Ic. t. 239 f. 2; Jacq. Ic. rar. t. 289 sub *Ixia fenestrata*; Curtis's Bot. Mag. t. 184 & t. 704; Nature Notes **7** (1923); this work **Fig. 6**.

This species is very closely related to *T. squalida*, resembling the latter in its corm, leaves, spike, bracts, stamens and pistil, and also in the hyaline marginal zones on the claws of the perianth. It differs from *T. squalida* in

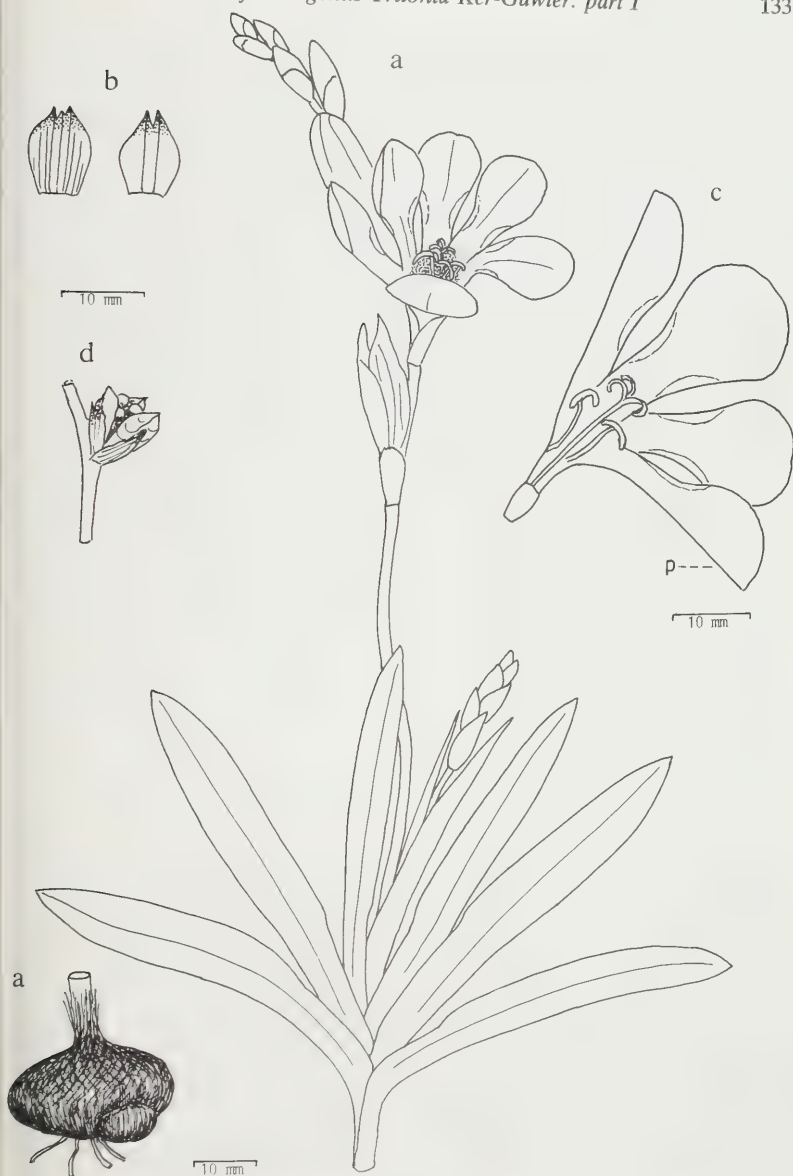


FIG. 6.  
*Tritonia crocata* (De Vos 2424): a, plant; b, outer (left) and inner (right) bract; c, inverted flower half in a median section; d, dehiscent capsule; p, posticous perianth segment.

the following characters: *Flowers* bright fiery orange or orange-red (RHS 28A, 33B), sometimes pinkish-orange, *Perianth segments* obovate-spathulate, without prominent veins, the three anticus segments in the throat furnished with a narrow yellow median stripe variable in length and sometimes raised to form a low (less than 1 mm high) callus.

Flowering period: September to November.

Distribution: Cape south coastal districts from Swellendam to George and rarely to Humansdorp and Tulbagh (Fig. 4A).

CAPE—3319 (Worcester): Prope Tulbagh (-AC), *Ecklon 811* (MO).

—3322 (Oudtshoorn): Georgetown (-CD), *Prior s.n.* (K); Touws River, Wilderness (-DC), *Taylor 4118* (PRE, STE).

—3420 (Bredasdorp): In campis ad Swellendam (-AB), *Zeyher PRE 36543*, *MacOwan s.n.* (K); 15 mls from Skipskop to Swellendam (-AD), *Admiraal 165* (PRE); Heidelberg (-BB), *Swart STE 11683*; 2.6 mls from Heidelberg to Riversdale, *Mauve 4579* (STE).

—3421 (Riversdale): West of Riversdale (-AA), *Thompson 3281* (PRE, STE), *Barker 8215* (NBG); Between Heidelberg and Riversdale, *Middlemost 2185* (NBG); East of Heidelberg, *Goldblatt 4957* (MO); 8 km from Riversdale to Albertinia (-AB), *Mauve 4582* (PRE); Riversdale, *Van der Spuy s.n.* (STE), *Walters 137* (NBG), *Jordaan 784* (STE), *Bayliss 2421* (NBG, not in G); 4 mls on the Riversdale-Garcias road, *Goldblatt 454* (BOL); Albertinia (-BA), *Muir 876* (BOL, PRE, MO), *Middlemost 1831* (NBG); Along Albertinia-Mossel Bay road (-BA-B), *Van Breda 1228* (PRE); Herbertsdale (-BB), *Heese s.n.* (STE); Between Gouritz River and Mossel Bay, (-BA), *Lewis 3654* (SAM), *PRE 36541*; 15 mls E of Albertinia (-BB), *Acocks 21551* (PRE); Gouritz River Mouth (-BD), *Horrocks 38* (NBG).

—3422 (Mossel Bay): Mossel Bay distr., *Hops 27* (BOL); Braakfontein, Mossel Bay, *Middlemost 1825* (SAM, NBG); Voorbaai (-AA), *Black s.n.* (BOL); Municipal rubbish heap, Mossel Bay, *Strauss 37* (NBG); Between Klein Brak and Hartenbosch, *Burchell 6199* (K).

—3424 (Humansdorp): Humansdorp (-BB), *Middlemost 1812* (BOL, NGB).

Without precise locality: *Ecklon & Zeyher Irid 279* (B, MO); *Metelerkamp NBG 1735/26*; *Thom 973* (K); *Ecklon 811* (S); *Ecklon sub T. sanguinea* (S); *Thunberg ann. 1773* (S); *Thunberg Hb. 944* (UPS); *Meijer sub T. fenestrata* (C); *Burman Hb. sub Ixia crocata*, *I. planifolia*, *I. crocea* (G).

Linnaeus described *Ixia crocata* in the second edition of the *Species Plantarum* (1762), citing Miller's figure 156 f. 1. He corrected this error in *Systema Vegetabilium* (1767). As Linnaeus's description is clearly based on the plant in his herbarium (the holotype) and not on Miller's figure, *T. crocata* is taken to date from 1762 (see also Goldblatt, 1972 sub t. 1655). Probably misled by the error in the *Species Plantarum*, Delaroche described a similar plant as *I. iridifolia* (1766), believing it to be a new species. His name is a later synonym of *I. crocata*.

The two species *T. crocata* and *T. hyalina* are conspecific. The early descriptions of *T. crocata* (as *I. crocata*) by Linnaeus (1762), Curtis (1791), Thunberg (1783) and Aiton (1789) state that the lobes of the "petals" or "corolla" are hyaline at their bases. The only hyaline zones that have ever

been found in *Tritonia* are marginal on the claws, as described for *T. hyalina*. This feature is also shown in Miller's figure t. 239 f. 2 which Linnaeus cites with *I. crocata* (1767) and in *Bot. Mag.* t. 184 of *I. crocata*, as well as in t. 704. The last mentioned, named *T. fenestrata*, is a *T. crocata* with narrower perianth segments.

Baker (1896), in trying to maintain the two species, *T. crocata* and *T. hyalina*, changed the description of *T. crocata* by omitting to mention the hyaline zones on the perianth. According to him *T. hyalina* differs from *T. crocata* in the perianth segments being spatulately narrowed into a claw with an inflexed hyaline margin. As stated above, however, the old descriptions of *T. crocata* did mention hyaline zones at the bases of the perianth segments.

Specimens without hyaline claw margins, figured as *T. crocata* in *Nature Notes* no. 6:5 (1923) and in *Flowering Plants of Africa* 42 pl. 1655 (1972) are therefore not this species, but are *T. miniata* (now treated as a subspecies of *T. deusta*).

*T. crocata* is also closely related to *T. deusta* subsp. *miniata*, differing from this in its characteristic hyaline zones on the claw margins, also in having very little or no yellow colouring within the base of the perianth tube; the flower colouring is slightly more towards a fiery red. Fresh material can readily be distinguished but in herbarium specimens the yellow colouring usually fades, and if the claws are not well preserved, there is no way of identifying the two taxa. The distribution of *T. crocata* is slightly more towards the east than that of *T. deusta*, but in the Riversdale-Albertinia region the ranges overlap. Here intermediates have been found.

### 3. *Tritonia deusta* (Ait.) Ker-Gawler in Curtis's *Bot. Mag.* 17 t. 622 (1803).

The species is closely related to *T. squalida*, resembling the latter in its corm, leaves, spike, bracts, stamens and pistil. It differs from *T. squalida* in the following features: *Flowers* bright reddish-orange or orange-salmon (RHS 28A, B). *Perianth tube* inside with a yellow, often red-margined star-shaped base, with six or twelve short yellow radiating lines (fresh material); *segments* without hyaline margins on the claws, the outer segments with a dark reddish-black blotch or median stripe in the throat and a low ridge or callus in the centre of each blotch, or the anticus segments with a small yellow, sometimes red-margined blotch or small dark blotch.

*Flowering period:* September to October.

*Distribution:* Cape southern districts from Caledon to Riversdale, Robertson and Montagu, and very rarely in the Cape Peninsula and the Stellenbosch district (Fig. 4B).

The two species, *T. deusta* and *T. miniata*, are here combined under



*T. deusta* as they are connected by a continuous series of intermediates. De Candolle, in Redouté's *Liliacées* (1804) also regarded these two taxa as conspecific, naming the species *Ixia miniata* var. *A* and var. *B*, the latter with the epithet *nigro-maculata*.

The species, *sensu lato*, has its flower colouring almost as in *T. crocata*, but slightly more towards the orange side. It differs in the absence of hyaline marginal zones on the claws of the perianth, and in the presence of a distinct, yellow, often red-margined star-shaped base within the perianth tube, with six or twelve short radiating lines; also in the presence of a reddish-black or a yellow blotch on some perianth segments. The yellow base and yellow blotches unfortunately fade in dried material.

Variation occurs in the number, size and shape of the dark blotches on the perianth. Specimens with a reddish-black blotch (which does not fade in dried material) or a dark median stripe on the three outer segments belong to subspecies *deusta*; those without these blotches are subspecies *miniata*. Intermediates show a single small dark spot or line on the median, or all three anticus segments. Such have been found along the road-sides between Riviersonderend and Caledon, amongst populations of the typical subspecies, as well as in the Bredasdorp district between Arniston and Elim amongst populations of subspecies *miniata* (*De Vos* 2432, 2433 in STE). Some old collections, e.g. *Ecklon & Zeyher* 103 in S, from Riviersonderend, Swellendam, also have such intermediate forms, and *Zeyher* 3974 in K and other herbaria consists of both subspecies.

Similar variation was recognised by several earlier workers. Andrews (1797) for example, was able to recognise "19 distinct varieties" of *Ixia deusta* in the close investigation he had given them over a number of years. He found them "to sport in colour &c. from the same root but much more so from seed". Most of these varieties probably originated as garden hybrids. In South African gardens the "kalkoentjies" which are popular garden plants, also hybridise readily.

Hybridisation undoubtedly also occurs in the veld, for example between the two subspecies of *T. deusta* already mentioned, as well as between *T. deusta* subsp. *miniata* and *T. crocata*.

#### a. subspecies *deusta*

*Tritonia deusta* (Ait.) Ker-Gawler in Curtis's Bot. Mag. **17** t. 622 (1803) & in Kon. & Sims, Ann. Bot. **1**: 227 (1805); Klatt in Linnaea **32**: 762 (1863) & in Dur. & Schinz, Consp. Fl. Afr. **5**: 204 (1895); Bak. in J. Linn. Soc. **16**: 162 (1877) & Handb. Irid. 190 (1892) & in Fl. Cap. **6**: 119 (1896).

*Ixia deusta* Ait. Hort. Kew. **1**: 60 (1789); Willd., Sp. Pl. **1**: 205 (1797). Type: Cape, Masson (BM, holo-).

*Tritonixia deusta* (Ait.) Klatt in Abh. Naturf. Ges. Halle **15**: 356 (1882).

*Ixia crocata* var. *a* Thunb. Diss. Ixia 17 (1783).

*I. crocata* var. *nigro-maculata* Andr., Bot. Rep. 2 t. 134 (1797).

*I. gibba* Salisb. Prodr. 38 (1796) nom. superfl. Type: as for *T. deusta*.

*I. miniata* var. *B, nigro-maculata* DC. in Red. Lil. t. 89 (1804); non Jacq.

*Tritonia coccinea* Eckl. Top. Verz. 29 (1827) e descr., no type found; non L. Bol.

Icones: Andrews, Bot. Rep. 2 t. 134; Curtis's Bot. Mag. t. 622; Red. Lil. t. 89; this work **Fig. 7**.

*Perianth* with a reddish-black blotch or stripe on the outer segments, usually with a medianly elongated raised ridge or callus in the centre of each blotch; blotches sometimes also on one or more inner segments.

CAPE—3318 (Cape Town): Inter Stellenbosch & Helderberg (-DD), *MacOwan* 953 (G partly, not BOL, SAM).

—3319 (Worcester): Boschjesmansrivier, Robertson (-DD), *Lewis* BOL 21734 (BOL, PRE).

—3320 (Montagu): Near Bonnievale (-CC), *Marloth* 11817 (STE, PRE), *Gillett* 1154 (BOL, STE); Near Ashton, *Van Breda* 1509 (PRE); Swellendam-Ashton road (CC/D), *Rousseau* 20 (STE).

—3419 (Caledon): 20 km E of turn-off to Krige (-BA), *De Vos* 2429 (STE).

—3420 (Bredasdorp): 5–9 km E of Stormsvlei (-AA), *De Vos* 2428 (STE); Between McGregor and Stormsvlei, *Lewis* 6101 (NBG); 10 mls from Riviersonderend to Swellendam, *Mauve* 4581 (PRE, STE partly); Bushmans River, Swellendam (-AB), *Barker* 1326 (BOL, NBG); Between Swellendam and Stormsvlei (-AA/B), *Goldblatt* 2925 (MO); Kathoek (-AD), *Acocks* 22750 (PRE); Heidelberg (-BB), *Muir* SAM 11420, *Swart* STE 11143, *Stayner s.n.* 20–10–62 (NBG); Swellendam am Ufer des Rivierzonderend bei Appelskraal, *Zeyher* 90.9 (G); Swellendam auf Hügeln by Puspasvalei, *Ecklon & Zeyher* Irid 103 (G, MO); Bredasdorp (-CA), *Uys* STE 25442.

—3421 (Riversdale): 10 mls W of Riversdale (-AA), *Richmond* 6 (NBG); Riversdale streets, *Muir* PRE 36559; Around Riversdale, *Muir* 2968 (BOL), *Loubser* 2046 (NBG); 5 mls S of Riversdale on Blombos road, *Lewis* 5637 (NBG); Between Riversdale and Albertinia (-AB/BA), *Pillans* 1229 (BOL).

Without precise locality: *Ecklon & Zeyher* 106 (SAM), *Irid* 103 (S); *Ecklon* (S, C); Breede River *Thom* (K); Coll. *Burman* sub *Ixia crocata* & *I. iridifolia* (G); sub *I. maculata* & *I. iridifolia* (L); sub *I. crocata* var. (*Bergius* scripsit) (S).

This subspecies is readily distinguished by the dark blotch on the outer perianth segments which remains visible even in old herbarium material. Specimens with a single small dark spot or line on the anticus segment are regarded as intermediates between the two subspecies, e.g. *De Vos* 2434.

Invariably a thickened ridge-like callus occurs in the centre of each dark blotch or stripe, as dark as the blotch itself. Willdenow (1797), Ker-Gawler (1803) and De Candolle in Redouté's *Liliacées* (1804) also noted these ridge-like excrescences.

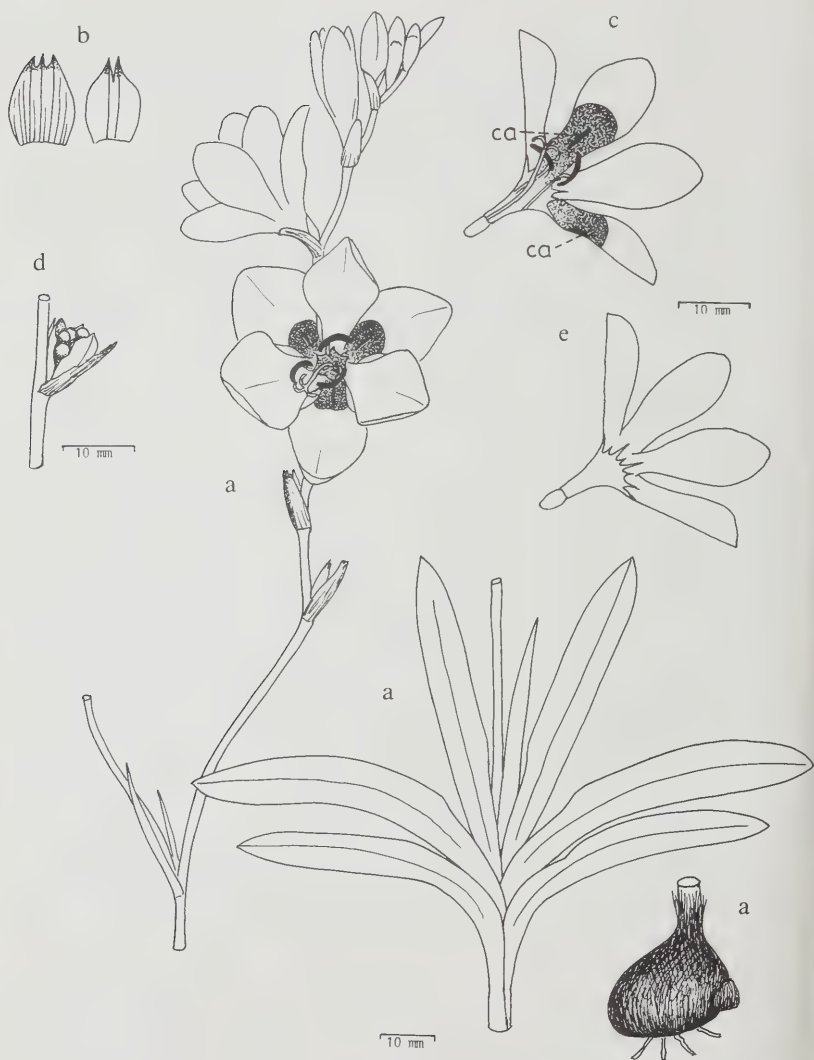


FIG. 7.

*Tritonia deusta* (De Vos 2428): a–d, subsp. *deusta*: a, plant; b, outer (left) and inner (right) bract; c, flower half in a median cut; d, dehiscent capsule; e, subsp. *miniata* (De Vos 2435), perianth half; ca, callus.

b. subspecies **miniata** (Jacq.) De Vos, comb. nov.

*Ixia miniata* Jacq. Hort. Schoenbr. 10 & t. 24 (1797) & Fragm. 28 & t. 32 f. 1 (1809). Type: Hort. Schoenbr. t. 24, icono, lecto. -*I. miniata* var. A, DC. in Red. Lil. sub t. 89 (1804).

*Tritonia miniata* (Jacq.) Ker-Gawl. in Curtis's Bot. Mag. 17 t. 609 (1803) & in Kon. & Sims, Ann. Bot. 1: 228 (1805); *Eckl.* Top. Verz. 30 (1827); Klatt in Linnaea 32: 761 (1863) & in Dur. & Schinz, Consp. Fl. Afr. 5: 206 (1895); Bak. in J. Linn. Soc. 16: 162 (1877).

*Tritonixia miniata* (Jacq.) Klatt in Abh. Naturf. Ges. Halle 15: 356 (1882).

*Ixia crocata* var.  $\beta$  sensu F. Delar. in Red. Lil. 6: 335 (1811).

*Tritonia crocata* sensu Bak. Handb. Irid. 190 (1892) & in Fl. Cap. 6: 119 (1896), as to descr., excl. syn.; sensu Goldbl. in Flow. Pl. Afr. 42 pl. 1655 (1972).

*T. crocata* var. *miniata* (Jacq.) Bak. in Handb. Irid. 190 (1892) & in Fl. Cap. 6: 119 (1896); Lewis in Adams. & Salter, Fl. Cape Penins. 841 (1950).

*T. aurantiaca* Eckl. Top. Verz. 29 (1827) e descr., no type found.

Icones: Jacq. Hort. Schoenbr. t. 24 & Fragm. t. 32 f. 1; Curtis's Bot. Mag. t. 609; Red. Lil. 6 t. 335; Nature Notes no. 6 opp. p. 4 sub *T. crocata*; Flow. Pl. Afr. 42 pl. 1655.

*Perianth* without a dark blotch or stripe on the outer segments; anticous segments sometimes with a yellow, often red-margined blotch or small dark spot or median line.

CAPE—3318 (Cape Town): Rondebosch (-CD), *Drège s.n.* (K); Lion's Head, Signal Hill, *Marloth 5645* (PRE); Lower slopes of Lion's Head off Kloofnek Road, *Foley BOL 24932* (BOL, PRE), *SAM 60145*; Lion's Head slopes, *Ecklon & Zeyher SAM 21202*; Inter Stellenbosch and Helderberg, *MacOwan 953* (BOL, SAM, and G partly).

—3412 (Caledon): 3 km W of Elim (-DA), *De Vos 2434* (STE); Farm Heuningrus between The Poort and Elim (-DB), *Van der Merwe NBG 62916*; Between Napier and Bredasdorp (-DB), *De Vos 2432* (STE).

—3420 (Bredasdorp): Regione Swellendam. (-AB), *Ecklon 812* (PRE); In campis ad Swellendam, *Pappe SAM 21202*; Below 10 o'clock Mt., *Wurts 476* (NBG); Swellendam auf Hügeln bei Puspasvalei, *Drège Irid. 104* (G); Suurbraak (-BA), *Wiese NBG 569/34*; Heidelberg (-BB), *Loubser 2047* (NBG); Arniston (-CA), *Van Breda 1478* (PRE); Near Waenhuiskrans, *De Vos 2433* (STE); Die Mond (-CC), *Thompson 3235* (PRE); Struisbaai, *Leipoldt 3603* (BOL).

—3421 (Riversdale): 13 mls W of Riversdale (-AA), *Lewis 5569* (NBG); Near Riversdale (-AB), *Van Breda & Admiraal PRE 30284*; Aasvoëlberg, Albertinia (-BA), *Bohnen 7722* (STE).

Without precise locality: *Ecklon* (C); *Zeyher 3974* (G); sub *T. miniata* (L).

Variation occurs in the markings on the perianth. In 1797 Jacquin described and figured *I. miniata* as having flowers with a yellow base and twelve yellow lines radiating from this: six longer lines opposite the middle of each segment and six shorter lines below the sinuses between the segments. Twelve years later (1809) he broadened the circumscription of the species to include specimens with a yellow blotch in the throat on the three anticus segments. Ker-Gawler's plant in the *Botanical Magazine* t. 609 also shows a yellow blotch on the three anticus segments, whereas Redouté's figure 335 shows four yellow blotches.

Plants with a perianth similar to Jacquin's iconotype (1797) occur in the Bredasdorp district a few kilometres from the coast. They are dwarf, starved plants with considerable variation in the length and number (6 or 12) of the yellow lines radiating from the base and in the presence of a red margin to the yellow base; also in the presence (or absence) of a short dark-red median line or spot on one, or all three, anticus segments. Those with dark spots are regarded as intermediate between the two subspecies.

Variation apparently also occurs in collections found on Signal Hill near Cape Town: Marloth's no. 5645b in PRE has a note, "The posterior segment (i.e. the originally anticus) with a dark spot at its base"; whereas other collections, e.g. *Foley* (BOL 24932), show no dark spots.

4. *Tritonia dubia* Eckl. ex Klatt in *Linnaea* **32**: 761 (1863) & in Dur. & Schinz, *Consp. Fl. Afr.* **5**: 205 (1895); Bak. *Handb. Irid.* 194 (1892) & in *Fl. Cap.* **6**: 124 (1896). Type: Cape, Uitenhage, *Ecklon & Zeyher Irid.* 102 (B, holo-, not extant; SAM spec. no. 1, lecto-; S partly, G iso-).

*T. dubia* Eckl. *Top. Verz.* 30 (1827) nom. nud.; Nordenstam, in *Jl S. Afr. Bot.* **38**: 292 (1972).

*Montbretia dubia* (Eckl. ex Klatt) Bak. in *J. Linn. Soc.* **16**: 169 (1877).

*Tritonixia dubia* (Eckl. ex Klatt) Klatt in *Abh. Naturf. Ges Halle* **15**: 356 (1882).

*Tritonia bolusii* Bak. in *J. Bot. Lond.* **14**: 337 (1876); Klatt in Dur. & Schinz, *Consp. Fl. Afr.* **5**: 203 (1895). Types: Cape, in campis graminosis pr. Uitenhage, *Bolus* 1883 (K, lecto-; BOL, S); C. b. Spei, *Zeyher* s.n. (K, syn-).

*Tritonixia bolusii* (Bak.) Klatt in *Abh. Naturf. Ges Halle* **15**: 356 (1882).

**Fig. 8.**

Type: The holotype, *Ecklon & Zeyher* 102 in B is no longer extant, according to an answer to my query to that herbarium. Isotypes were found in G, S, and SAM: in G a single plant; in SAM three specimens on the sheet, two of which are identical with that in G, and the third, with high calli



on the perianth, is probably *T. laxifolia*. The sheet in S has four species on it: one is identical with that in G, the second is *T. laxifolia* or *T. securigera*, and the other two are too poor to identify. That species occurring in all three above-mentioned herbaria is regarded as *T. dubia*, as it tallies with Klatt's description.

*Plants* 120–150(–250) mm long. *Corm* 8–20 mm diam.; tunic fibres fine, reticulate, subparallel near the base. *Scape* 120–150(–250) mm long, erect or slightly curved, sometimes branched near the base. *Leaves* 5–8, distichous, lanceolate-ensiform, suberect to curved and spreading, acute or subacute, with a slender middle vein, sometimes reaching up to the base of the spike; cauline leaves 0–2, short and narrow. *Spike* almost second, simple or sometimes 1–2-branched, with 5–8(–10) flowers. *Bracts* membranous, 5–10 mm long, sometimes slightly spreading; *outer* brown in the upper half, with colourless membranous margins, 3–4-toothed or irregularly toothed, or subacute; *inner* bidentate, 2-veined, as long as the outer or slightly shorter. *Flowers* regular, widely cup-shaped or almost salver-shaped, 18–25(–32) mm long, salmon-pink or orange-pink (RHS 31 B, C, 32D), with dark veins. *Perianth tube* 6–10 mm long, very narrow below, widened to 3 mm diam. at the top; *segments* subequal, ellipsoid, widely spreading, obtuse or sub-obtuse, 10–15(–20) × 4–6(–8) mm, without calli. *Stamens* erect, regularly placed; *filaments* 3–5 mm long; *anthers* 3–4.5 mm long, straight or later curved, pale yellow, reaching scarcely halfway up the perianth. *Ovary* 2–4 mm long; *style* erect, 7–8 mm; *stigmatic branches* spreading regularly between the anthers, 3–5 mm long, widened slightly at the tips, orange, not reaching the anther tips. *Capsule* elongated ellipsoid-trigonal, 25 mm long; *seeds* brown, 1.5–2 mm diam., with a minutely reticulate-foveate testa. *Chromosome number*  $2n = 22$ .

Flowering period: (July–)August–September.

Distribution: Eastern Cape Province in the Port Elizabeth and Uitenhage districts (Fig. 4A).

CAPE—3325 (Port Elizabeth): Zuurborg Pass, S side (-BC), Archibald 5252 (BOL); Between Zuurborg and Gamtoos River drift (-CC), Fourcade 3988 (K, STE); Prope Uitenhage (-CD), Harvey 141 (K), Bolus 1883 (BOL, K, S), Dahlstrand 533 (GRA), Loubser 909 (NBG); Bronnereservaat, Uitenhage, Olivier 2553 (STE); The Springs, Uitenhage, Halfstrom & Lindeberg s.n. (S); Winterhoek mts in convalle Hell's Gate kloof, Fries e.a. 986 (S); Auf den Grasfeldern am Zwartkopsrivier (-DC), Ecklon 102 (S partly, SAM partly), Ecklon 141 (BOL), Ecklon & Zeyher 141 (SAM); Prope Port Elizabeth, Fries e.a. 334, 468 (S), Galpin 3071 (BOL); Bluewater Bay, Urton s.n. (STE); Perseverance, P.E., Rodin 1248 (BOL, K, S); Redhouse, Paterson 44 (BOL), Rogers 3620 (BOL); Prince Alfred's Park, P.E., Cook BOL 31766; Coega (-DC), Bayliss 1620 (B).

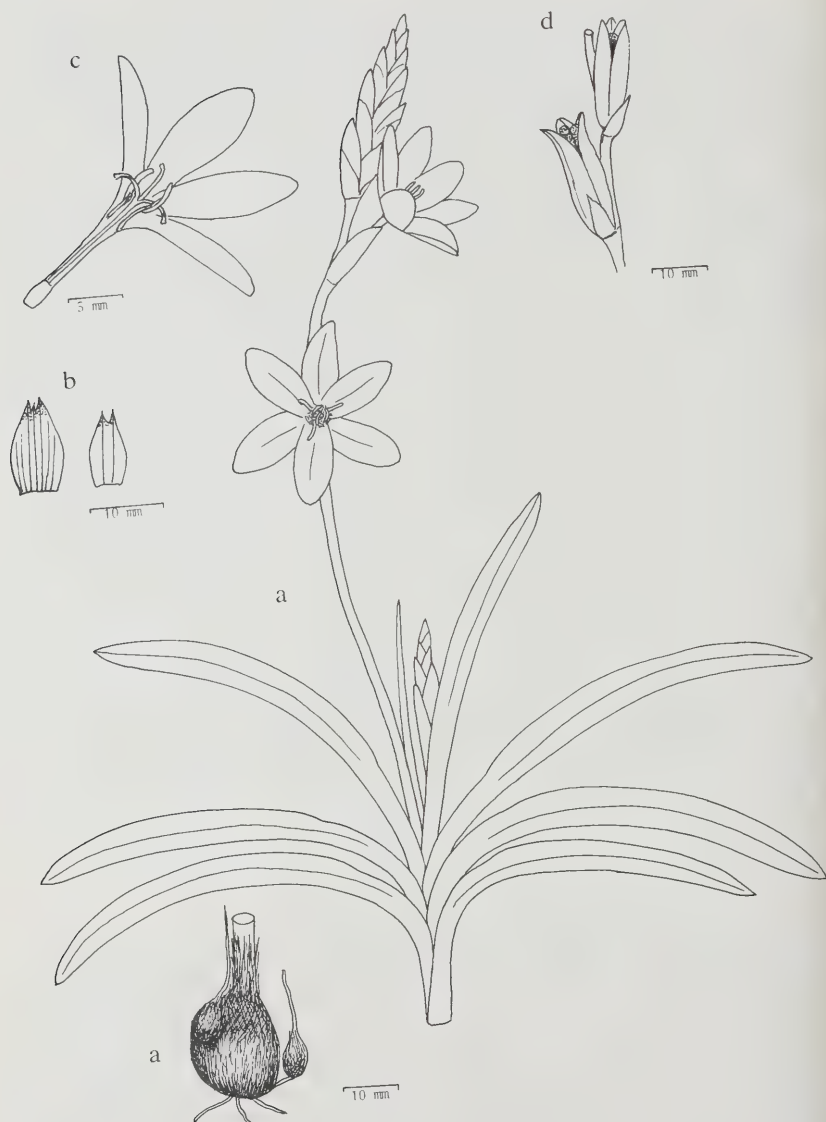


FIG. 8.

*Tritonia dubia* (Olivier 2553): a, plant; b, outer (left) and inner (right) bract; c, flower half; d, dehiscing capsules.

This species is a link between *Tritonia* and *Ixia*. It has the regular flower of an *Ixia* with the colouring of a *Tritonia*; the erect, regularly placed stamens of *Ixia*, with anthers which later often curve somewhat randomly as in *Tritonia* section *Tritonia*; the young spike is flattened in the bud stage as in *Tritonia*. What is more, the leaf margins do not have the strands of sclerenchyma of *Ixia*, but are typical of *Tritonia* with its strengthened epidermis.

## 2. Section PECTINATAE De Vos, sect. nov.

*Folia* lanceolata v. linearia v. teretia, sulcata, v. cristis longitudinalibus quatuor praedita, marginibus laevibus v. crispis v. revolutis. *Spica* densiflora, fere pectinata. *Bracteae* plerumque marginibus supernis rubro-brunneis. *Flores* zygomorphi, suberecti, albi v. rosei, fauce perianthii rubro-notata, tubo bis ad ter longiore quam segmentis, segmentis anticis angustioribus quam posticis. *Antherae* violaceae.

*Type species: T. crispa* (L.f.) Ker-Gawler

*Leaves* lanceolate or linear or sometimes terete and grooved, or with four longitudinal flanges, the margins smooth or crisped or revolute. *Spike* dense, almost pectinate. *Bracts* usually with dark reddish-brown upper margins. *Flowers* zygomorphic, suberect, white, cream or pink, with red or purple markings in the throat, with the perianth tube twice to thrice longer than the segments, the anticus segments narrower than the posticus ones. *Anthers* violet or purple.

*Distribution:* South-western Cape Province from Vanrhynsdorp to Riversdale, and in the Prince Albert district of the Great Karoo (Fig. 9). Four closely related species are recognised which differ mainly in their leaf structure. Only *T. tugwelliae* has the typical ensiform unifacial leaf structure common in the Ixiodeae. In the other three species the lamina is formed by two or four new outgrowths of the abaxial surface (De Vos, 1982). Two species have undulate or crisped margins.

The species are readily distinguished by their dense, almost pectinate spikes with long-tubed whitish to pinkish, zygomorphic flowers, and bracts with dark reddish-brown, crisped upper margins. The flowers are sometimes partially or wholly inverted. The anthers are contiguous and are placed towards or against the posticus perianth segment, facing the anticus side. The median anticus segment sometimes shows a slight median thickening in the throat, homologous with the calli of section *Montbretia*.

Only *T. crispa* is treated in the *Flora Capensis* as a *Tritonia*, under subgenus *Tritonia* *Proper*. *T. cooperi* is under *Ixia* and *T. lancea* (*Ixia lancea* Thunb.) is not mentioned. The fourth species, *T. tugwelliae*, was described later.

5. *Tritonia crispa* (L.f.) Ker-Gawler in Curtis's Bot. Mag. **18** t.678 (1803), excl. syn. *Gladiolus laceratus* Burm.

Plants (180-)250-350(-450) mm long. *Corm* cone-shaped, 10-20(-30) mm diam.; tunic fibres fine, almost parallel. *Scape* (150-)250-350(-450) mm long, suberect or slightly bent, simple or with 1-3 branches, with a collar of old leaf bases 30-80 mm long around its base. *Leaves* 3-6(-8), linear-lanceolate, acute or acuminate, suberect, (100-)200-300(-400) × (5-)10-15(-25) mm, usually with crisped, often ciliolate margins and with a prominent middle vein, reaching up to the base of the spike; cauline leaves 1-3, linear, up to 150 mm long. *Spike* dense, secund, with 4-12 or more flowers, often slightly bent to give it a pectinate appearance. *Bracts* membranous, sometimes greenish in the lower portion, with dark reddish-brown upper margins, (5-)7-12(-15) mm long; outer irregularly 3-toothed or slightly lacerated or obtuse, with crisped upper margins; inner bidentate, as long as or slightly shorter than the outer. *Flowers* zygomorphic, suberect, (40-)50-80(-110) mm long, cream, pale yellow, shell pink or salmon pink (RHS 37C, D), with a red or purple centre and median stripe on the anticus perianth segments. *Perianth tube* (20-)40-50(-70) mm long, cylindrical in the lower half, widened gradually to 7 mm diam. in the upper portion, slightly curved, 2.5-3 times longer than the segments; *segments* unequal, (12-)15-20(-25) mm long, the posticus segments suberect, obovate-spathulate, 5-13 mm wide, the others spreading, 3-10 mm wide, the three lower ones oblanceolate, narrower than the others. *Stamens* almost central; *filaments* 8-12 mm long, erect; *anthers* 3-6 mm long, dark purple or purplish-black, facing the anticus side, reaching scarcely halfway or up to three-quarters up the perianth segments. *Ovary* subglobose, 3-5 mm long; *style* (32-)40-70(-85) mm, erect; *stigmatic branches* 3-6 mm long, overtopping the anthers. *Capsule* shortly ellipsoid-trigonus, ca. 7 mm long; *seeds* brown, shiny, minutely reticulate-foveate, 2 mm diam. *Chromosome number*  $2n=22$ .

Flowering period: late September to December.

Distribution: Widely distributed in the western and south-western Cape from Vanrhynsdorp to the Cape Peninsula and Worcester and to Caledon (Fig. 9A).

*T. crispa* is readily distinguished by its long-tubed flowers borne in a dense, almost pectinate spike, its bracts with dark reddish-brown, slightly crisped upper margins, and by a type of unifacial leaf formed by two longitudinal outgrowths from the abaxial surface (De Vos, 1982), and usually with crisped margins. The flowers are often somewhat inverted, with the anticus segments in the posterior or lateral position.

Ker-Gawler (1803) transferred *Gladiolus crispus* L.f. to *Tritonia*, tenta-

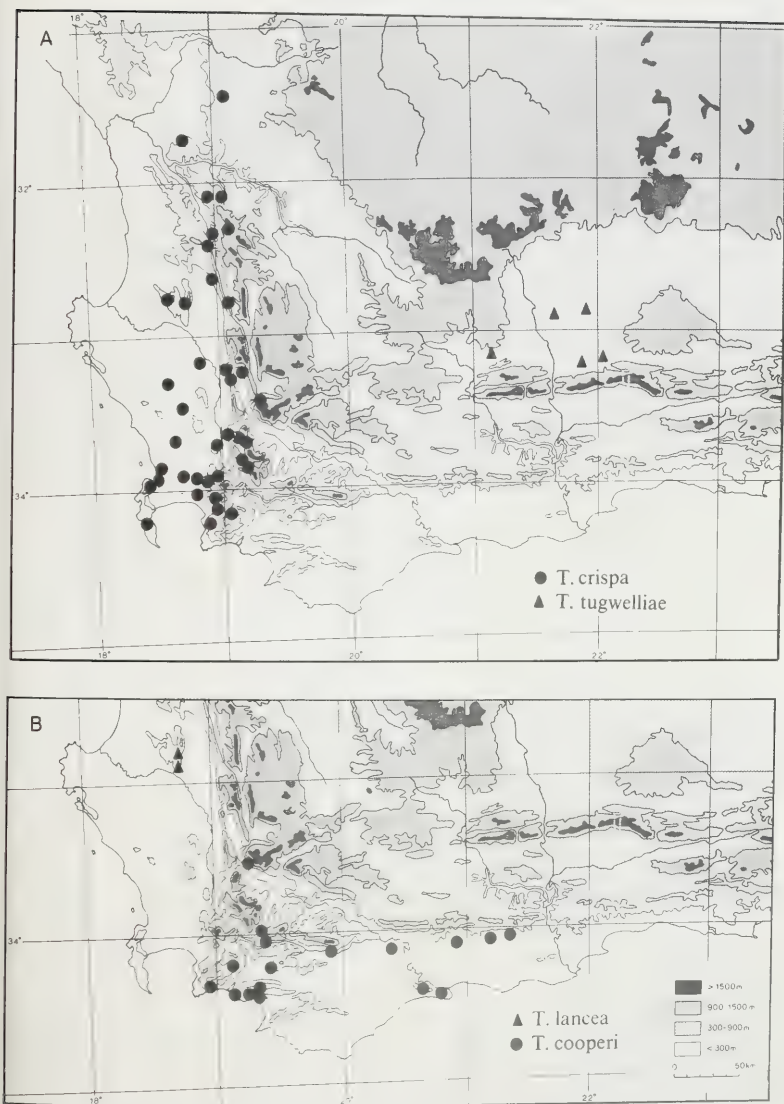


FIG. 9.  
Geographical distribution of *Tritonia* section *Pectinatae*: A, *T. crispa* and *T. tugwelliae*; B, *T. lancea* and *T. cooperi*.



tively citing as synonym also *G. laceratus* Burm. Prodr., with a question mark. Baker (1877) accepted Ker-Gawler's citation of Burman's species and named the species *Montbretia lacerata*; but in 1892 and 1896 he used Ker-Gawler's name for the species, citing as synonyms *G. crispus* L.f. and also *G. laceratus* Burm. without any reservations. When investigating the South African Iridaceae in Burman's herbarium in Geneva, N.E. Brown (1929) found no type of *G. laceratus*; nor has a type been found during the present investigation. Burman's synoptic description of the species (1768), "foliis ensiformibus laceris, floribus secundis, tubo filiformi longissimo" is too vague to connect his species unequivocally with *T. crispa*, as it can also be the description of a species belonging to several other Iridaceous genera. For this reason Burman's epithet *laceratus* is unacceptable for the present species.

Baker's *T. crispa* var. *pectinata* is a different species, namely *T. lancea*. His var. *grandiflora* is incorporated with the typical variety, as a series of intermediate sizes occurs between this variety and the typical variety. His var. *parviflora* is accepted.

a. var. **crispa** (L.f.) Ker-Gawler in Curtis's Bot. Mag. **18** t. 678 (1803), excl. syn. *Gladiolus laceratus*; & in Kon. & Sims, Ann. Bot. **1**: 228 (1805); Ait. Hort. Kew. ed. 2, **1**: 90 (1810); Klatt in Linnaea **32**: 756 (1863); Bak. Handb. Irid. 192 (1892) & in Fl. Cap. **6**: 122 (1896), excl. var.  $\beta$  &  $\delta$  syn. *Gladiolus laceratus*; Lewis in Adams. & Salter, Fl. Cape Penins. 250 (1950).

*Gladiolus crispus* L.f. Suppl. 94 (1781); Thunb. Diss. Gladiolo **10** & t. 1 f. 2 (1784) & Fl. Cap. 191 (1811); Ait. Hort. Kew. Add. 481 (1789); Jacq. Ic. t. 267 (1789) & Coll. **5**: 27 (1796); Andr. Bot. Rep. t. 142 (1797); Willd. Sp. Pl. **1**: 210 (1797). Type: Cape, *Sparrman* 123, sub *Gladiolus crispus* (LINN 59.18, holo-).

*Freesea crispa* (Ker-Gawl.) Eckl. Top Verz. 30 (1827), nom. illeg., gen. non descr.

*Montbretia lacerata* Bak. in J. Linn. Soc. **16**: 168 (1877), excl. var. *pectinata* & syn. *Gladiolus laceratus*.

*Tritonia lacerata* (Bak.) Klatt in Abh. Naturf. Ges. Halle **15**: 358 (1882), excl. syn. *G. laceratus*.

*T. laccata* Klatt in Dur. & Schinz, Consp. Fl. Afr. **5**: 205 (1895), orth. var.

Icones: Curtis's Bot. Mag. t. 678; Jacq. Ic. t. 267; Andr. Bot. Rep. t. 142; this work Fig. **10**.

*Bracts* 7–12(–15) mm long. *Flowers* more than 50 mm long. *Perianth tube* longer than 28 mm. *Style* longer than 40 mm.



FIG. 10.

*Tritonia crispa* (De Vos 2435): a, plant; b, leaf sheath and base of lamina; c, outer (left) and inner (right) bract; d, inverted flower; p, posticus perianth segment.

CAPE—3118 (Vanhynsdorp): Gifberg slopes (-DB), *Goldblatt* 346 (BOL), *Barker* 9577 (NBG), *Werderman & Oberdieck* 498 (PRE); Summit of Gifberg Pass, *Hall* 3898 (NBG).

—3119 (Calvinia): Nieuwoudtville (-AC), *Leipoldt* BOL 3174.

—3218 (Clanwilliam): Pakhuis Pass (-BB), *Middlemost* 1910 (NBG); Uitkyk Pass between Alpha & Algeria (-BD), *Goldblatt* 3270 (MO); Boontjiesrivier near Citrusdal (-DB), *Pillans* 9840 (BOL); Olifants River valley, *Leipoldt* BOL 17110; Piketberg (DA), *Bolus* s.n. Oct. 1892 (BOL), *Barker* 7577 (NBG), *Drège* s.n. (K); Base of Kapiteinskloof, *Pillans* 7812 (BOL).

—3219 (Wuppertal): Krakadouwhoogte & Boskloof (-AA), *Leipoldt* 540 (SAM); Cedarbergen (-AC), *Thode* A2181 (PRE); The Baths, Citrusdal (-CA), *Emden* 80 (PRE).

—3318 (Cape Town): Malmesbury near Oudepost (-BC), *Acocks* 15231 (PRE, BM); Towards Heuningberg (-BB), *Thomas* s.n. Oct. 71 (STE, NBG); Malmesbury (-BC), *Hall* 165 (NBG), *Goldblatt* 3134 (MO); Signal Hill (-CD), *Marloth* 11456 (BOL); Sub Kasteelpoort, *MacOwan* 2389 (K); Lion's Head, *Wolley-Dod* 3648 (BOL); Lion's Rump, *Pappe* s.n. (K); Paarden Eiland, *Ecklon* s.n. Sept. 1828 (SAM); Am Meeresstrand and bei Rietvalei, *Zeyher* 4020 (S); Blaauberg, *Zeyher* 4020 (SAM); Klipheuwel farm (-DA), *Joubert* s.n. Oct. 46 (NBG); Paarl (-DB), *Prior* PRE 36539, *Prior* s.n. (K); Paarl Mountains, *Drège* 1840 (K); Langverwacht above Kuilsrivier (-DC), *Oliver* 4795 (PRE); S spur of Kanonkop, *Acocks* 1351 (S); Between Cape Town and Stellenbosch (-DC-D), *Hafstrom* s.n. Nov. 34 (S); Stellenbosch flats (-DD), *Duthie* 213 (STE-U); Papegaisberg (-DD), *Taylor* 7843 (STE); Jonkershoek, *Kerfoot* 6102 (NBG), *Garside* 1168A (K), *Kruger* 82 (STE); Joostenberg, *Mathews* s.n. Oct. 37 (BOL); Banhoek, *Martley* BOL 31744; Ida's Valley catchment, *Taylor* 9274 (PRE); Beside Helshoogte road, *Acocks* 3600 (S).

—3319 (Worcester): Distr. of Worcester, *Cooper* 1510 (BOL, K); Saron (-AA), *Thudichum* BOL 31746; Prope Saron, *Schlechter* 10625 (PRE G, L, S, BM, MO); Slopes of Roodesandberg, *Compton* e.a. 1882/36 (NBG); Tulbagh (-AC), *Ecklon* 107 (SAM), *Ecklon* s.n. (C, S); Near Tulbagh waterfall, *Isaacs* BOL 31745; Witelskloof off Mitchells Pass (-AD), *Esterhuysen* 14156 (BOL); Du Toitskloof (-CA), *Pillans* 8491 (BOL), *Hall* s.n. Nov. 49 (NBG); Groenberg, *Van Rensburg* 7 (PRE, MO), *Grant* 7 (BM); Bainskloof, *Grant* 2237 (MO); Franschoek (-CC), *Phillips* 1317 (SAM); Wemmershoek Valley, *Esterhuysen* 17676 (BOL, PRE); Klein Drakenstein mts., *Kruger* 1531 (STE).

—3418 (Simonstown): Near Somerset West (-BB), *Martley* s.n. Dec. 30 (BOL); Skapenberg, Somerset West, *Lewis* 5675 (NBG, STE); Sir Lowry's Pass, *Barker* 3378 (NBG, STE), *MacOwan* 2996 (SAM); Hottentots Holland bergen, *Bolus* 5254 (BOL), *MacOwan* 1657 (SAM, BM, K, G), *Stokoe* 6166 (BOL), *Zeyher* 1265 (S); Kogelbaai bridge (-BD), *Boucher* 908 (PRE, STE).

—3419 (Caledon): Prope Grabouw, Palmiet River (-AA), *Bolus* 4212 (BOL).

Without precise locality: Thunberg Hb. 1018 (UPS); *Thunberg* sub *Gladiolus crispus* (S); *Sparrman* 123 (LINN); *Drège* *Irid.* 106 (G).

The flowers of Lewis's collection no. 5675 (NBG, STE) from Skapenberg above Vergelegen, Somerset West, have shorter perianth tubes (25–28 mm) which are only slightly longer than the segments, and shorter styles (32–35 mm). It was identified as *T. undulata* (Burm. f.) Bak., but is not this species. Its other characteristics fit *T. crispa* and it is regarded as a luxuriant form of the latter.

b. var. **parviflora** Bak. Handb. Irid. 192 (1892) & in Fl. Cap. 6: 122 (1896). Syntypes: C.b.S. without precise locality, *Thom s.n.* (K, lecto-); Winterhoek, Tulbagh, *Pappe s.n.* (K). These two collections are on a single herbarium sheet. The former, comprising two scapes with little crispulation, is probably what Baker described as "leaves linear, not crisped", and is therefore chosen as lectotype.

*Bracts* 5–7 mm long. *Flowers* 30–40(–45) mm long. *Perianth tube* (18–)20–25(–28) mm long; *segments* ca. 8–10 mm long. *Style* 20–28(–33) mm.

CAPE—3219 (Wuppertal): Hill slopes about 4 mls SE of Citrusdal (-CA), *Barnard* SAM 68459.

—3318 (Cape Town): Stellenbosch flats (-DD), *Garside* 70 (K).

—3319 (Worcester): Winterhoek, Tulbagh (-AA), *Pappe s.n.* (K); Tulbagh (-AC), *Hofmeyr* STE 16962, *Theron* STE 16965, *Ecklon s.n.* (C).

—3418 (Simonstown): Prom. b. Spei (AB/D), *Masson* (BM).

Without precise locality: *Thom* (K); *Ecklon* 106 (B); *Verreaux* (G); *Pappe* SAM 21195; *Roxburg* (BM); sub *Freesea crispa* & *Ixia undulata* (L); sub *Gladiolus crispus* & *Freesea crispa* (S).

6. ***Tritonia lancea*** (Thunb.) N.E.Br. in J. Linn. Soc. Bot. 48: 48 (1928). Type: C. b. Sp., infra Piketberg, Thunberg Hb. 963 (UPS, holo-).

*Ixia lancea* Thunb. Diss. *Ixia* 18 (1783) & Fl. Cap. 246 (1811); Willd. Sp. Pl. 1: 206 (1797), excl. cit. Jacq.; Vahl, Enum. Pl. 2: 62 (1805); non Jacq. 1790 & 1796.

*Ixia pectinata* Vahl, Enum. Pl. 2: 62 (1805). Type: Cap. b. Sp., Hb. Vahl (C, holo-).

*Tritonia pectinata* (Vahl) Ker-Gawl. in Curtis's Bot. Mag. sub t. 1275 (1810); Klatt in Abh. Naturf. Ges. Halle 15: 358 (1882) & in Dur. & Schinz, Consp. Fl. Afr. 5: 207 (1895).

*Montbretia lacerata* Bak. var. *pectinata* (Vahl) Bak. in J. Linn. Soc. 16: 168 (1877).

*Tritonia crispa* (L.f.) Ker-Gawl. var. *pectinata* (Vahl) Bak. Handb. Irid. 192 (1892) & in Fl. Cap. 6: 122 (1896).

*Plants* (100–)150–250(–280) long. *Corm* ovoid, 10–20 mm diam.; tunic fibres fine, matted, largely parallel but elongated-reticulate towards the top. *Scape* simple, (100–)150–250(–280) mm long, often slightly flexuose, with a fibrous collar of old leaf bases 40–50 mm long around its base. *Leaves* 4–5, linear-lanceolate or lanceolate, suberect, acute or acuminate, with inrolled margins, (50)100–200(–280) × 2–7(–10) mm, with a prominent middle vein seen from one side, often contracted between the sheath and blade into a petiole-like portion up to 100 mm long and 0.5–1.5 mm diam.; cauline



FIG. 11.

*Tritonia lancea* (De Vos 2450): a, plant, with one flower semi-inverted; b, outer (left) and inner (right) bract; c, inverted flower; d, flower half in a median cut; e, stamen and style branches; f, capsule.





FIG. 12.  
*Tritonia lancea*, holotype in the Thunberg herbarium, UPS.

leaves 1–2, terete towards the tip, up to 70 mm long, 1–2 mm wide. *Spike* somewhat secund and pectinate, simple, with 2–7 suberect flowers, rarely reduced to a single flower. *Bracts* membranous, with dark reddish-brown, minutely crisped upper margins, 7–10(–12) mm long; outer shortly 3-toothed or irregularly toothed, finely veined; inner shortly bidentate, 2-veined, often with a greenish base. *Flowers* slightly zygomorphic, salver-shaped, often inverted, (32–)40–50 mm long, white, with two short red lines on each anticous segment, with the tube and outer segments brownish-red on the backs. *Perianth tube* (17–)20–25 mm long, cylindrical for most of its length, widened slightly at the top to 5 mm diam.; *segments* subequal in length, spreading, oblanceolate or oblong, obtuse, rarely slightly emarginate, 12–18 mm long, the posticous segments 7–10 mm wide, anticous 5–7 mm wide. *Stamens* curved slightly towards the posticous side; *filaments* 6–7 mm long, white; *anthers* 5 mm long, violet, reaching half-way up the perianth segments; pollen white. *Ovary* 3 mm long; *style* 22–30 mm long, white; *stigmatic branches* 3–4 mm long, reaching or overtopping the anther tips. *Capsules* shortly ellipsoid, 5–7 mm long; *seeds* ca. 1 mm diam., brown, testa colligulate.

Flowering period: late August to September.

Distribution: Foot, lower slopes and top of Piketberg (Fig. 9B).

CAPE—3218 (Clanwilliam): Top of Piketberg (-DC), *De Vos* 2406 (STE); *De Hoek* (-DD), *Lewis* 1850 (SAM), *Barker* 7327, 4677 (NBG).

Without precise locality: *Thunberg* 963 (UPS); *Hb. Vahl*. sub *Ixia pectinata* (C); *Masson* sub *Gladiolus pectinatus* (BM partly). (Masson's "prom. b. Spei" on the herbarium sheet probably does not refer to the Cape Peninsula but to the Cape in general.)

This species is distinguished by white salver-shaped flowers with red markings, arranged in an almost pectinate spike, and by leaves which have a lanceolate or linear-lanceolate lamina with inrolled margins and often an almost terete contracted middle portion between the lamina and sheath. The flattened unifacial lamina is formed by two outgrowths of the abaxial surface (*De Vos*, 1982).

*T. lancea* has a limited distribution on the slopes and on top of Piketberg, where it is still quite common. *Thunberg* indicated his locality as "infra Piketberg" (1811) in the first edition of his *Flora Capensis*.

*Ixia pectinata* *Vahl*, with its holotype in C, is this species; *Vahl*'s name is therefore a later synonym. He probably did not see the type of *I. lancea*, as he questioned (1805) under *I. pectinata*: "An eadem cum *Ix. lanceae* *Thunbergii*?"

Masson's collection in BM labelled *Gladiolus pectinatus*, comprises two

species, namely *T. lancea* and *T. cooperi*. This resulted in the wide-leaved specimens of *T. cooperi* being misidentified as *T. pectinata* and *T. crispa* var. *pectinata* in some South African and overseas herbaria. (See further under *T. cooperi*.)

*T. lancea* is closely related to *T. crispa*.

7. *Tritonia cooperi* (Bak.) Klatt in Abh. Naturf. Ges. Halle **15**: 358 (1882).

*Plants* (200–)400–600 mm long. *Corm* 15–30 mm diam., ovoid; tunic fibres very fine, matted, almost parallel towards the base, elongated-reticulate towards the top. *Scape* (120–)200–600 mm long, simple or with one branch, with a collar of old leaf bases 40–70 mm long around its base. *Leaves* 4–6, grooved, terete or almost quadrangular or with four longitudinal flanges (H-shaped or X-shaped in transverse section), acuminate or acute, with straight, sometimes sparsely ciliolate margins, (200–)300–500 × (0,5–)2–7(–10) mm, with a strong vein in the middle, reaching to the base or top of the spike; cauline leaves 1–2, linear, acuminate, 30–120 mm long. *Spike* dense, secund, pectinate, often slightly bent at its base, with 5–10 flowers, sometimes with one branch. *Bracts* membranous, sometimes greenish towards the base, with dark reddish-brown upper margins, 5–10(–13) mm long; *outer* with a wide, irregular or shortly 3-toothed, crisped upper margin; *inner* shortly bidentate, 2-keeled upwards, equal to or slightly longer or shorter than the outer. *Flowers* zygomorphic, erect to suberect, often half inverted, (45–)60–75(–80) mm long, white or cream, becoming pink with age, with red or purple markings in the throat, often pink outside. *Perianth tube* largely cylindrical, widened gradually in the upper half or quarter, to 5–8 mm diam. at the top, often slightly curved, (30–)40–55 mm long, ca. 2 to 3 times longer than the segments; *segments* unequal, obtuse, somewhat spreading, 12–18(–24) mm long, posticous segments elliptical to obovate-spathulate, (5–)10–13(–18) mm wide, the median one slightly wider than the laterals, the anticus segments oblanceolate-spathulate, (4–)6–9 mm wide. *Stamens* slightly curved towards the posticous perianth segment; *filaments* 8–12(–16) mm long, pale; *anthers* 4–6(–8) mm long, dark violet, reaching halfway to three-quarters up the perianth segments; pollen violet. *Ovary* 2,5–4 mm long; *style* (42–)50–65 mm long, suberect; *stigmatic branches* 3–5(–7) mm long, often overtopping the anthers.

Flowering period: November to December

Distribution: In the districts of Worcester, and Caledon to Riversdal (Fig. 9B).



FIG. 13.

*Tritonia cooperi* var. *quadrialata* (De Vos 2439): a, plant with one flower inverted; b, outer (left) and inner (right) bract; c, half of flower in a median cut.

This species was described as *Morphixia cooperi* by Baker (1876) and transferred to *Tritonia* by Klatt (1882). In 1892 and 1896 Baker combined *Morphixia* with *Ixia* and the species became *Ixia cooperi*. At the same time Baker described a different species as *Tritonia cooperi*, based on a different collection of Cooper. (As this is a later homonym of *T. cooperi* Klatt, Foster (1936) renamed that species *T. quinquenervata*, an unnecessary name, as L. Bolus (1929) had already shown it to be no *Tritonia* and had named it *Watsonia cooperi* (Bak.) L. Bol.—see Lewis, 1941).

The younger Linnaeus described *Gladiolus longiflorus* (1781) and cited a specimen of Thunberg. There is no Thunberg specimen so named in the Linnean herbarium (only of Sparrman which is *Acidanthera* and which cannot be considered as representing the type of *G. longiflorus* L.f., according to N. E. Brown, 1928). In Thunberg's herbarium in UPS are two sheets, labelled *G. longiflorus*  $\alpha$  and  $\beta$  respectively. They represent two species:  $\alpha$  (sheet No. 1040) is *Tritonia bakeri* and  $\beta$  (sheet No. 1041) is *T. cooperi*. (Brown did not realise that two species were involved.) One of these should be regarded as the type of Linnaeus's name. His short diagnosis fits both sheets equally well, and Thunberg's more detailed description in *Dissertatio de Gladiolo* (1784), although incorporating both species, fits  $\beta$  best. The name *T. longiflora* cannot, however, be accepted for either species, as it is a later homonym of *T. longiflora* (Curtis) Ker-Gawler (1805) (which belongs in the genus *Ixia*). Brown, aware of this, suggested (1928) that the combination *T. longiflora* (L.f.) N.E. Br. be conserved; but Foster (1936) renamed the species *T. longituba* Foster, unaware that valid names, *T. cooperi* and *T. bakeri*, were available for it. As Linnaeus's name *G. longiflorus* may be regarded as referring to both sheets of Thunberg, it is cited in the present revision with both *T. cooperi* and *T. bakeri*.

*T. cooperi* is distinguished by its white, cream or pale pink, long-tubed flowers which often become darker pink with age, and which are arranged in a dense pectinate spike; and by narrow, terete, four-grooved leaves, or wider four-flanged leaves which are X-shaped or H-shaped in transverse section. The four flanges are pressed flat in herbarium material, giving the leaves a linear-lanceolate outline. The species differs from *T. lancea* in this, as well as in its more zygomorphic, larger flowers with longer perianth tube and longer style.

Two subspecies are recognised, differing mainly in leaf width: subspecies *cooperi*, with narrow, four-ridged leaves, occurs mainly on stony hills and mountain slopes; whereas subspecies *quadrialata*, with wider four-flanged leaves, is generally found in more mesophytic habitats usually at lower altitudes. Basically the leaf structure is similar in the two subspecies, the four wide longitudinal flanges of the latter subspecies being wider outgrowths of the ridges between the grooves of the narrow leaves of the former. A few



collections, e.g. *Schlechter* 29386 in BOL, from the vicinity of Cape Infanta, have specimens which seem to connect the two subspecies.

#### KEY TO THE SUBSPECIES

Leaves terete, grooved, or X-shaped in transverse section, 1–2(–6) mm in diam.  
 ..... a. subsp. **cooperi**  
 Leaves with four wide longitudinal flanges, H-shaped in transverse section, 6–10  
 mm wide ..... b. subsp. **quadrialata**

#### a. subspecies **cooperi**

*Tritonia cooperi* (Bak. 1876, non 1892, nec 1896) Klatt in Abh. Naturf. Ges. Halle **15**: 358 (1882).

*Morphixia cooperi* Bak. in J. Bot. Lond. **14**: 237 (1876) & in J. Linn. Soc. **16**: 98 (1877). Syntypes: Cape, district of Worcester, *Cooper* 1683 (K, lecto-); same locality, *Cooper* 1628 (K).

*Ixia cooperi* (Bak.) Bak. Handb. Irid. 166 (1892) & in Fl. Cap. **6**: 84 (1896).

*Gladiolus longiflorus* L.f. Suppl. Pl. 96 (1781) in part; Thunberg, Diss. Glad. 19 (1784) in part, excl. syn. Berg. & Delar. & spec.  $\alpha$  in Hb. Thunb; & Fl. Cap. **1**: 207 (1811) in part. Non Jacq. (1789), nec Vahl (1805). Type: Thunberg Hb. 1041 (UPS, lecto-).

*Tritonia longiflora* (L.f.) N.E. Br. in J. Linn. Soc. **48**: 25 (1928) in part, excl. spec.  $\alpha$  in Hb. Thunberg, hom. illeg.; non Ker-Gawl. (1805), nec Ait. (1810 = *Ixia paniculata* Delar.)

*T. longituba* Foster in Contr. Gray Herb. N.S. **114**: 45 (1936) in part. Type as for *Gladiolus longiflorus* L.f.

*Leaves* terete, narrowly or widely 4-grooved, X-shaped in transverse section, 1–2(–6) mm wide, as long as the scape. *Bracts* 5–10 mm long. *Perianth tube* (30–)40–55 mm long; *segments* 12–18 mm long.

Often on stony hills, mountain slopes and ridges.

CAPE—3319 (Worcester): District of Worcester, *Cooper* 1628, 1683 (K); Slanghoek Needle, SW slopes at foot (-CA), *Esterhuysen* 17768 (BOL); Mountainside, Elandskloof near Villiersdorp (-CD), *Galpin* 12379 (PRE).

—3419 (Caledon): Houhoek (-AA), *Schlechter* 291 (PRE), 9385 (PRE, K, S), *Lewis* 5312 (NBG, STE, MO), *Loubser* 2144 (NBG); Caledon (-AB), *Jones s.n.* (STE); Donkerhoekberg, Caledon, *Zeyher* SAM 21226; Hermanus, Die Mond (-AD), *Erens* 2769 (PRE); Onrust River, stony slopes (-AC), *Esterhuysen* 19278 (BOL).

—3420 (Bredasdorp): Swellendam, am Berge bei Puspasvalei, Voormansbosch etc. (70.10), *Irid* 96 (G, not MO); Bontebok Park, Swellendam (-AB), *Grobler* 545 (STE), *Marais* 68 (PRE); Grootvadersbos, Heidelberg (-BB), *Barker* 8827 (NBG, C, MO, S).

—3421 (Riversdale): Foot of Langebergen between Vet River and Krombeks River (-AA), *Burchell* 7183 (K); Corenterivier farm, *Muir* 5365 (BOL, PRE), 5366 (PRE); Glen, rocky slopes (-AB), *Muir* 3022 (BOL).

Without precise locality: Cap. bon. Spei, Thunberg Hb. 1041 (UPS); Thunberg Hb. ann. 1774 (S); Prom. b. Spei, *Masson* (BM partly).

This subspecies has sometimes been confused with *T. bakeri*, e.g. in Thunberg's herbarium in UPS, on account of its narrow leaves and long-tubed flowers. It is, however, readily distinguished by its dense pectinate spike with zygomorphic flowers and by its 4-ribbed leaves.

b. subspecies **quadrialata** De Vos, subsp. nov.

A subspecies typica foliis laterioribus, quadrialatis differt.

*Type:* Cape, Potberg, Bredasdorp, *Tropper s.n.* 16–11–65 (STE, holo-).

*Leaves* with four longitudinal flanges, H-shaped in transverse section, (seemingly linear-lanceolate in herbarium specimens), 6–10 mm wide, reaching up to the base of the spike or higher. *Bracts* 7–13 mm long. *Perianth tube* 35–45(–50) mm long; *segments* 15–18(–24) mm long.

CAPE—3418 (Simonstown): Betty's Bay, Porter Reserve (-BD), *Topper* NBG 77197; Betty's Bay, *Brunt* BOL 31748.

—3419 (Caledon): Kleinmond flats (-AC), *Cloete* NBG 70754; Onrust River mountain, S.E. slopes, *Esterhuysen* 4234 (BOL), 19278 (SAM); Botrivier–Hawston road, *Barnard* NBG 93824; Protea farm near Botrivier, *Thomas* NBG 70506; S foot of Riversonderend mts. near Sonderend (-BB), *Esterhuysen* 23793 (PRE).

—3420 (Bredasdorp): Bontebok Park, Swellendam (-AB), *Acocks* 22893 (PRE); Potberg (-BC), *Tropper s.n.* 16–11–65 (STE); Rietfontein near Cape Infanta (-BD), *Esterhuysen* 29386 (BOL).

Without precise locality: *Roxburgh s.n.* (G).

This wide-leaved subspecies has been misidentified in South African and some overseas herbaria as *T. pectinata* Ker-Gawler or *T. crispa* var. *pectinata* Baker. This is on account of Masson's collection in BM which is labelled *Gladiolus pectinatus*, a manuscript name of Solander, and also *T. pectinata* Gawl., and is believed to be the type material of *T. pectinata*. This collection comprises four specimens belonging to two species: three specimens are identical with a specimen named *Ixia pectinata* Vahl in C. As Ker-Gawler cited Vahl when he published the combination *T. pectinata* (1810), the holotype of the latter is this specimen in Copenhagen which, on examination proved to be identical with the type of *T. lancea* (Thunb.) N.E. Br., in Thunberg's herbarium in UPS. *T. pectinata* and *T. crispa* var. *pectinata* are therefore synonyms of *T. lancea* and are not the present subspecies. The fourth specimen of Masson's collection, left without a valid name, is a wide-

leaved, large-flowered form of *T. cooperi* and is now supplied with the epithet *quadrialata*, on account of its four-flanged leaves.

Seedlings and plants still too young to flower have their two basal leaves linear-lanceolate and 2-flanged, with inrolled margins, resembling the leaves of *T. lancea*. Specimens of *Horn s.n.*, 25 Oct. 1958, in NBG, from Van der Wattskraal, Riviersonderend, Swellendam, also have flat leaves, up to 20 mm wide, with inrolled margins as in *T. lancea*. The inflorescence and flowers, however, are of this species.

8. *Tritonia tugwelliae* L. Bol. in Ann. Bol. Herb. 4: 45 (1926). Type: Cape, near Prince Albert, *Tugwell s.n.* BOL 13487 (BOL, holo-).

*Plants* (100–)150–250(–300) mm long. *Corm* 10–22 mm diam., conical; tunic fibres strong, elongated-reticulate. *Scape* (100–)150–250(–300) mm long, curved below the spike, sometimes with one branch. *Leaves* 4–5, linear-lanceolate, falcate, spreading or recurved, 50–100 x 3–7(–9) mm, with undulate or crisped or sometimes straight margins, with a slender middle vein. *Spike* dense, secund, pectinate, with 5–10 or more flowers. *Bracts* membranous, pale to pale reddish-brown, with narrow, pale, papery margins, 3–8 mm long; *outer* obtuse, acute or shortly 3-toothed, veined; *inner* 2-dentate, with 2 veins. *Flowers* zygomorphic, suberect, 32–40 mm long, white, with a small red or purple spot on the lower perianth segments. *Perianth tube* (20–)24–30 mm long, cylindrical in the lower half, widened gradually in the upper to 3 mm diam., segments oblong-spathulate, 7–9 x 2–3 mm, the lower slightly narrower than the upper. *Stamens* slightly bent; *filaments* 3–4 mm long; *anthers* ca. 3 mm long, at first blue, reaching about halfway up the perianth segments. *Ovary* ca. 2 mm long; *style* (24–)27–33 mm long; *stigmatic branches* ca. 2 mm, reaching or overtopping the anther tips.

Flowering period: September.

Distribution: South-western part of the Great Karoo, from Prince Albert towards Leeugamka and Laingsburg (Fig. 9A).

CAPE—3221 (Merweville): 3.5 mls N of Prince Albert Road station (-DC), *Acocks 17106* (PRE); 7 mls S of Fraserburg station (-DD), *Zinn SAM 59771*.

—3321 (Ladismith): 27 mls NE of Laingsburg towards Beaufort West (-AA), *Lewis 3490* (PRE); 20 mls W of Prince Albert (-BB), *Leistner 240* (PRE).

—3322 (Oudtshoorn): Prope Prince Albert (-AA), *Tugwell BOL 13487*; Prince Albert, "flowering in my garden", *Marloth 11455* (PRE).

Without precise locality: Roggeveld, hb. Worsdell (K).

This species, found only in a small area of about 80 by 55 km in the Great Karoo, is readily distinguished by its white, long-tubed flowers arranged in a pectinate spike and by leaves usually with undulate-crisped

margins. Its leaves resemble *T. crispa* superficially, but are softer in texture, usually bent, and of the ordinary ensiform-unifacial type. It differs from the latter species further in its smaller flowers, bracts without dark upper margins, and corm tunics with stouter fibres arranged in an almost regular reticulation.

3. Section TERETIFOLIAE De Vos, sect. nov.

*Folia* teretia v. subteretia, valida, striata ubi exsiccata, pluribus filis validis sclerenchymatis praedita. *Bracteae* herbaceae in dimidio inferiore. *Flores* zygomorphi, plerumque inversi, fere rubinei, tubo perianthii ca. duplo longiore quam segmentis, segmentis interioribus laterioribus quam exterioribus.

*Type species: T. kamisbergensis* Klatt

*Corm* deep underground. *Leaves* terete or subterete, wiry, striate when dry, with several strong strands of sclerenchyma. *Bracts* herbaceous in the lower half. *Flowers* zygomorphic, usually inverted, almost ruby-red, the perianth tube obliquely funnel-shaped, about twice the length of the segments, and the inner segments wider than the outer. *Stamens* curved against the posticous perianth segment, with the anthers contiguous and facing the anterior side of the flower.

*Distribution:* Kamiesberg, Namaqualand.

This section has a single species which shows several features not typical of *Tritonia* generally, such as the deep-seated corm, wiry, filiform leaves, bracts which remain herbaceous in their lower portion, and almost ruby-red flowers with two slight protuberances on the perianth tube where the two posticous stamens are inserted.

9. *Tritonia kamisbergensis* Klatt in *Linnaea* **32**: 760 (1863) & in Dur. & Schinz, *Consp. Fl. Afr.* **5**: 205 (1895); Bak. *Handb. Irid.* 193 (1892) & in Fl. Cap. **6** 123 (1896). Type: Cape, Kamiesbergen, *Ecklon & Zeyher* 109 (B, holo-; SAM).

*Montbretia kamisbergensis* (Klatt) Bak. in *J. Linn. Soc.* **16**: 169 (1877).

*Tritonixia kamisbergensis* (Klatt) Klatt in *Abh. Naturf. Ges. Halle* **15**: 356 (1882).

*Freesea kamisbergensis* Eckl. in herb.

**Fig. 14.**

*Plants* 500–700 mm long or sometimes longer. *Corm* deep-seated, asymmetrical; tunic fibres fine, more or less parallel, forming thick matted layers. *Scape* 400–600 mm long, simple or sometimes with 1–2 branches, with a dense tuft of dried leaves at the base. *Leaves* 5–6 or more, wiry, filiform, terete or subterete, acuminate, striate when dry, 600–700 × 1–3 mm, often



FIG. 14.

*Tritonia kamisbergensis* (De Vos 2448): a, plant; b, an inverted flower; c, outer (left) and inner (right) bract; d, flower half in a median section; e, style branches and stigmas.



longer than the scape; cauline leaves 1–3, 30–180 mm long, very narrow. *Spike* distichous, rather lax, with 4–12 flowers, sometimes with 1–2 branches. *Bracts* herbaceous in the lower half, becoming membranous in the upper, with brown tips, 5–8 mm long; outer acute, acuminate, or lacerated or sometimes minutely 3-toothed; inner bidentate, as long as the outer or slightly longer, 2-veined. *Flowers* zygomorphic, (26–)30–35 mm long, often inverted, almost ruby-red (RHS 60A–C), drying to purple. *Perianth tube* 16–20 mm long, funnel-shaped, curved, sometimes twisted, widened gradually from the base to ca. 8 mm diam. at the slightly oblique mouth, with two slight protuberances at the insertion of the stamens; *segments* unequal, 8–12 mm long, obtuse, with the inner wider than the outer and the posticous segment largest, subrotund, 10–12 mm wide, concave, hooded, others oblong or shortly obovate, 6–9 mm wide, the three anticus lobes with a wide, white, median line running down to the tube. *Stamens* curved towards the posticous segment; *filaments* 12–15 mm long, pale; *anthers* 4–6 mm, contiguous, bright violet, later paler; pollen pale. *Ovary* ca. 2 mm long; *style* (18–)20–25 mm long, curved, pale; *stigmatic branches* 1.5–2 mm long, widened and minutely crisped at the tip, reaching the anther tips. *Capsules* subglobose, ca. 4 mm long.

Flowering period: November to early December.

Distribution: In rocky fissures on the Kamiesberge, Namaqualand.

CAPE—3018 (Kamiesberg): 73.12 (= Namaqualand, Reise nach Kamiesberg, Boschmanland bis zur Mündung des Garieps), Ecklon & Zeyher s.n. (L), *Irid.* 109 (MO, S), Zeyher s.n. (G); Kamiesbergen, Ecklon & Zeyher 109 (SAM, B), Taylor 5543 (STE); Upper slopes of Rietkloof mts., Pearson 5706 (BOL, SAM, K); On a rocky ridge ca. 33 km from Garies towards Platbakkies (-AC), Malan s.n. sub De Vos 2448 (STE).

Without locality: sub *Freesea kamiesbergensis* Eckl. (S).

On account of herbarium specimens with badly preserved flowers and the absence of a corm, this species was incompletely known until recently when it was collected by M. E. Malan on a rocky ridge of the southern Kamiesberg.

It is distinguished by its corm which is deeply embedded in rocky fissures, its long, wiry, filiform leaves some of which often overtop the spike, bracts which remain herbaceous in their lower half, and by *Gladiolus*-like flowers, almost ruby-red in colour, with a long, curved, funnel-shaped perianth tube. Baker erroneously described the perianth segments as twice as long as the tube (1892, 1896).

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## BOOK REVIEWS

**MOSES OF SOUTH AUSTRALIA.** by D. G. Catcheside, 1980, with pp. 364. Handbook of the Flora and Fauna of South Australia series. Obtainable from: Publications Office, Government Publications Sales, 282 West Beach Road, Netley, South Australia 5037. Austr. \$ 13.20.

Published as part of the handbook series on the flora and fauna of South Australia, the *Mosses of South Australia* was written "to enable the student of mosses to identify each of the species to be found in the state and adjoining arid zone". The author, D. G. Catcheside, has gone far beyond this objective by producing a handbook that will not only encourage and teach the beginner but provide critical and accurate information to the scientific community on the mosses of this interesting area.

The book is small (A5–210 × 146 mm) and easily handled. The printing is generally quite good, using 8 pt type throughout. One unfortunate exception is line 15 on the first page of the introduction where the first part of the line was not properly printed in either of the copies I have examined. The paper is a good quality glossy finish, that reproduces both the black-and-white and colour illustrations well. The gatherings of 8 pages are sewn and the perfect binding includes a cover of heavy card that appears durable.

The introduction contains several interesting and concise sections dealing with *Life History and structure*, *Perennation and survival*, and *Microscopical techniques*, and several shorter sections covering such diverse topics as *General ecology*, *Cultivation of mosses*, and *Cytology*. The latter are too short to do much more than stimulate interests, but the references included will provide starting points for anyone interested in pursuing the subjects.

The body of the text treats the 179 species of mosses known from South Australia. The taxonomic treatment begins with a general key to genera and species. This is followed by a useful section on the higher classification of mosses, where Catcheside's concepts of the categories between class and family are circumscribed. At the back of the book is a glossary, bibliography and comprehensive indices of subject and taxonomic entries.

The general key worked easily and quickly for all examples tested, with the single exception of a sterile specimen of *Gigaspermum repens*; a fertile specimen keyed without difficulty. Reference to page numbers, like the ones provided in the separate species keys, would have been a very helpful addition.

Families and genera are described (except monotypic taxa) and bibliographic references are given for each, but notes about these categories are few. Each species is clearly and concisely described with bibliographic information, relevant synonymy, distribution (Australian and world), and occasional notes.

Each species is illustrated by line drawings of at least a leaf and leaf cells, although most figures contain many other important characters. The figures are accurate and well presented and certainly enhance the book. There are no captions to the figures; individual drawings are lettered and a corresponding letter is inserted in the species description at the appropriate place. Although most of the drawings are self-explanatory, the description does not always clearly reflect what has been illustrated. The lettering in figure 129 does not correspond with that given in the text; but this appears to be an isolated example.



Habit drawings are almost entirely restricted to the very small species; the beginner will undoubtedly find this a disadvantage. The 12 black-and-white and 45 colour habit photographs, covering 22 families, should however help to fill the gap. The sharpness, depth of field and background of the photos are frequently distracting; however the photos certainly convey the "nature" of the plants.

*Mosses of South Australia* is an extremely important contribution to bryology and the first modern moss flora for an Australian state. It will be indispensable for anyone seriously interested in studying Southern Hemisphere mosses. The book is especially important in the study of southern Africa mosses because of the large number of common taxa. Practically all of the genera treated in the book occur in the Flora of Southern Africa area. A couple of exceptions are *Dawsonia* and *Dicnemoloma*, genera that indicate the australasian influence on the South Australian Flora.

ROBERT E. MAGILL

JOURNAL OF GARDEN HISTORY, Volume I No. 1 January–March 1981. (An International Quarterly), editor J.D. Hunt. Taylor & Francis, 4 John St., London, England. Vol. 1 No. 1, pp. 1–111. Annual subscription £30.

During the past decade there has been a noticeable upsurge of interest in the history of gardens and gardening. Indeed, a veritable avalanche of books examining the subject from every conceivable angle, has appeared on the market. Like the building of great houses, the creation of great gardens by inspired, well-endowed individuals, now seems to be luxury that belongs to a distant age. Happily, however, there appears to be a growing realisation that fine gardens are among man's most sublime artistic expressions. Perhaps it is this realisation, together with the current concern for the conservation or restoration of existing masterpieces, that has helped to generate an interest in garden history.

The *Journal of Garden History* is a new quarterly publication devoted to scholarly studies on the various disciplines which might be conveniently grouped under the wide umbrella of garden history. Architectural history, landscape design, horticulture, social history, engineering and many other activities that impinge on gardening, are among the topics the editor hopes to cover in future issues.

Volume 1 No. 1 of this praiseworthy publication contains five well-illustrated papers devoted to historic gardens in England and Europe. These contributions have certainly set a high initial standard. I read them with great pleasure although I often wished the authors had fleshed out their aesthetic assessments and detailed architectural descriptions with more information on the plant material used in the gardens upon which they so eloquently expounded.

Any person or organisation seriously interested in gardens or garden history should have this new journal on their bookshelves. One hopes it will be well supported and will find a wide, appreciative readership.

J.P. ROURKE

INDEX HOLMIENSIS, DICOTYLEDONEAE C, Volume V, with pp. 258, editor † Hans Tralau. Swedish Natural Science Research Council, Stockholm, 1981.

Volume 5 of the *Index Holmiensis*, covering letter C of the Dicotyledons, has

now appeared. This is another step forward in an ambitious plan to publish a compilation of references to distribution maps of the world's vascular plant species.

Since the death of the project's initiator, Dr. Hans Tralau, there has been a slight delay in the appearance of the present volume, but it is anticipated that future volumes will be issued at the rate of one every two years. Projects like this are daunting, even to the most optimistic, but one can only hope that having got so far, the authors will continue to receive the support they deserve and that in due course this index will reach the letter Z.

J.P. ROURKE



Jl S. Afr. Bot. 48 (2): 169-240 (1982)

## STUDIES IN THE GENERA OF THE *DIOSMEAE* (RUTACEAE): 13. A REVISION OF THE GENUS *ACMADENIA* BARTL. & WENDL.

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### ABSTRACT

Thirty-three species of the genus *Acmadenia* Bartl. & Wendl. are listed with diagnoses and keys. Descriptions have been prepared, where possible, from fresh material; distribution maps and lists of specimens examined are given. Five new species, *A. rourkeana*, *A. latifolia*, *A. maculata*, *A. baileyensis*, *A. faucitincta* are described.

### UITTREKSEL

STUDIES IN DIE GENERA VAN DIE *DIOSMEAE* (RUTACEAE): 13. 'N  
HERSIENING VAN DIE GESLAG *ACMADENIA* BARTL. & WENDL.

Die drie-en-dertig soorte van die geslag *Acmadenia* Bartl. & Wendl. met diagnose en sleutels word gekatalogiseer. Beskrywings is so ver as moontlik van vars materiaal gemaak; verspreidingskaarte en lysste van bestudeerde monsters word gegee. Vyf nuwe soorte, *A. rourkeana*, *A. latifolia*, *A. maculata*, *A. baileyensis*, *A. faucitincta* word beskryf.

### HISTORICAL BACKGROUND

The first species of *Acmadenia* to be described was written up as *Diosma tetragona* in 1781 by Linnaeus' son. It was collected by Sparrmann probably in the vicinity of Attaquas Kloof. About the same time Thunberg must have collected his *Diosma obtusata* in the vicinity of the Sundays River.

The generic name *Acmadenia* means sharp gland and refers to the conical gland at the apex of the anther which is to be found in some species in the genus. The name *Acmadenia* was proposed by Bartling & Wendl. in their revision of the *Diosmeae* published in 1824. Of the five species enumerated by them: *A. tetragona* (L.f.) Bartl. & Wendl. has been maintained and chosen as the type species of the genus; *A. pungens* has been transferred to *Euchaetis*; *A. laevigata* has also been transferred to *Euchaetis* but as *E. meridionalis* Williams to avoid creating a homonym; *A. obtusata* sensu Bartl. & Wendl. has been described de novo as *A. laxa* Williams; and *A. juniperina*

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has been found to be synonymous with *A. obtusata* (Thunb.) Bartl. & Wendl.

In 1830 Chamisso described *A. alternifolia* previously collected by Mund & Maire at Hangklip somewhere along the south Cape coast.

Ecklon & Zeyher in their *Enumeratio Plantarum* (1835) list eight species of *Acmadenia*, two of which, *A. flaccida* and *A. mundiana*, were new to science, four were misidentified and one *A. muraltioides* is a later synonym of *A. obtusata* (Thunb.) Bartl. & Wendl. One species originally placed in *Adenandra* by them was transferred to *Acmadenia* as *A. trigona* by Druce in 1917.

Sonder in his revision of the *Rutaceae* for the *Flora Capensis* (1860) recognised fourteen species. Of these six, *A. densifolia*, *A. nivenii*, *A. alternifolia*, *A. tetragona*, *A. mundiana* and *A. flaccida* have been maintained; three have been transferred to *Euchaetis* and one to *Agathosma*. Two have had their names changed and two others have been reduced to synonymy.

Link in his list of plants growing in the Royal Botanic Gardens at Berlin (1821) described *Diosma teretifolia* although his plant had at that time not yet bloomed. Phillips, who later examined the flowers, transferred it to *Acmadenia* in 1920.

Dümmer in *Fedde's Repertorium* (1913) described four species of *Acmadenia*, two of which, *A. gracilis* and *A. burchellii*, have been maintained, one *A. neglecta* reduced to synonymy with *A. mundiana* and one transferred to *Diosma* as *D. apetala*.

Glover, in the *Annals of the Bolus Herbarium* (1915), described one species, *Acmadenia heterophylla*, and proposed another as a variety of *A. obtusata* which Compton, in 1932, raised to the rank of species as *A. macropetala*.

Dümmer in the *Annals of the Bolus Herbarium* (1921) described *Diosma marlothii* from the Matroosberg, which Phillips, in the *Journal of South African Botany* (1943), transferred to *Acmadenia* as *A. matroosbergensis*.

*Acmadenia banosmoides* described by Dümmer in the *Journal of Botany* (1912) has been transferred to *Phyllosma* and *Acmadenia marlothii* described by Dümmer in the *Annals of the Bolus Herbarium* (1912) has been transferred to *Agathosma*.

Compton's *Diosma wittebergensis* published in the *Transactions of the Royal Society of South Africa* (1931) was transferred to *Acmadenia* in 1978.

Leading up to this paper eleven new names have been published in the *Journal of South African Botany* since 1974 and five more are included here.

#### DISTRIBUTION

All the species of *Acmadenia* except one, are to be found growing within an area in the South and South Western Cape Province that includes the



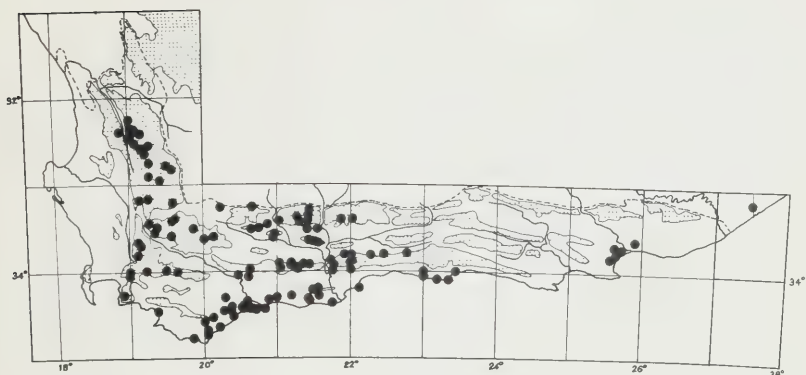


FIG. 1.

Known distribution of the genus *Acmadenia*. Line of dashes shows northern limit of Cape Geological Series. Dotted areas represent mountainous regions. Large black dots show actual areas where collections have been made.

mountain ranges of the Cape Geological Series marked on the map by a broken line (Fig. 1). A very isolated population of *A. kiwanensis* occurs further to the east where the plants are found growing associated with outcrops of quartzitic sandstone that may well be outliers of this geological series. The bulk of the species are concentrated between the 19 and 22 degree lines of longitude, that is from a line from Kogelberg to Clanwilliam in the west to about Mossel Bay in the east. No species of *Acmadenia* has so far been found to occur on the Cape Peninsula or on the coastal plain from False Bay northwards.

East of the Keurbooms River mouth, a disjunction of 210 km is found before *A. obtusata* occurs again in the vicinity of the Koega and Sundays Rivers. After a further disjunction of 165 km *A. kiwanensis* is found quite near to East London. All species of *Acmadenia* are to be found growing in soils associated with or derived from Table Mountain Sandstone, Witteberg Quartzite or the Bredasdorp Limestone beds. As far as is known they are never found growing in clay soils derived from the Malmesbury or Bokkeveld Series.

#### GENERIC DESCRIPTION

***Acmadenia*** Bartl. & Wendl. *Diosmeae* in Beitr. Bot. 1: 59 (1824); *A.* Juss. in Mém. Mus. Hist. Nat. Paris. 13: 473 (1825) excl. fig.; Don, Gard. and Bot. 1: 785 (1831); Eckl. & Zeyh., Enum. Plant.: 105 (1835); Endl., Gen. Plant. 2: 1158 (1840); Steud., Nom. Bot. 1: 17 (1841); Lindl. Veg. Kingd.: 471 (1853); Sond. in Fl. Cap. 1: 379 (1860); Benth. and Hook.,

Gen. Plant. 1: 289 (1862–1867); Engl., Pflanzenfam. 19a: 273 (1931); Dyer, Gen. S.Afr. Flow. Pl. 1: 290 (1975). Type species: *A tetragona* (Linn.f.) Bartl. & Wendl. (*Diosma tetragona* Linn.f.).

*Diosma* Thunb. Prodr. Plant. Cap. 1: 84 (1794) in part; Dietr. Synops. Plant. 1: 827 (1839).

*Adenandra* Eckl. and Zeyh. in part.

*Bucco* Roem. and Schult., Syst. Veg. 5: 444 (1819) in part.

*Shrubs* 0,3 to 1 m tall, usually single-stemmed at base. *Branches* short, variously bent, becoming glabrous; bark somewhat rough, greyish-brown. *Branchlets* short, fairly erect, usually puberulous, well clothed with leaves. *Leaves* 1,8–15 mm long, 1–4,2 mm broad, linear, linear-lanceolate, oblong-lanceolate, elliptic, ovate or orbicular, obtuse or acute, sessile or short-petiolate, often complicate when dry, erect, often imbricate, adpressed or spreading, gland-dotted, opposite or alternate; margins glandular-denticulate, ciliate or eciliate; midrib prominent. *Inflorescence* 4–25 mm diam., terminal, often solitary, pink or white. *Bracts* one or sometimes two, leaf-like or reduced. *Bracteoles* two, much reduced. *Calyx* deeply divided; lobes 5, persistent. *Petals* five, in most cases clawed, often bearded and bent inward at the throat. *Staminodes* five, vestigial or short, normally glabrous, glandular or pointed at the apex, not protruding. *Filaments* five, short, acicular, normally glabrous. *Anthers* five, 2-locular, dorsifixed, not protruding; apical gland immersed, semi-immersed, globose or pointed, or large and conical. *Pollen* triporate, oblong. *Disc* obvallate, exceeds the ovary, often equals the stigma at first. *Stigma* capitate. *Style* short, glabrous, usually erect, in 5 species only at some stage deflexed. *Ovary* normally 5-carpellate, about 1 mm diam., in 1 species 4-carpellate, 1 species 3-carpellate and 1 species 2-carpellate; apices globose, glabrous, puberulous or sparsely pubescent, sometimes bifid or sometimes retuse with an immersed gland. *Fruit* normally 5-carpellate (in one species, only one or two carpels develop to maturity), either exposed or hidden beneath the persistent calyx lobes, in most cases with horns very short. *Seed* usually 2,3–5,5 mm long, 1,3–2,2 mm broad, black, shining; aril white or partly black; exceptions are *A. wittebergensis* and *A. patentifolia* which have still larger seeds and *A. flaccida* where the seed is matt not shining.

#### DIAGNOSTIC CHARACTERS

The genus *Acmadenia* is distinguished by having: (1) petals clawed, if they are bearded then the beard not a transverse fringe of hairs as in *Euchaetis* but rather a rounded patch of pubescence; (2) staminodes present, although in some cases very short or rudimentary; (3) style and filaments very short, never carrying the stigma or the anthers beyond the throat of the flower; (4) anthers with an apical gland, in two species much reduced.

## ARRANGEMENT OF SECTIONS

The genus may be conveniently divided into the following sections:

1. *Acmadenia* section *Macrostylioides* which is distinguished by having only one or two carpels developing in each fruit. (Species no. 1).

2. *Acmadenia* section *Peltatiglandula* which is distinguished by having leaves, bracts and calyx lobes fringed with raised peltate or discoid glands. (Species nos. 2 to 4).

3. *Acmadenia* section *Patentipetalum* which is distinguished by having the petals spreading, revealing the gynoeceum. (Species nos. 5 to 11).

4. *Acmadenia* section *Glandula* which is distinguished by having the flower with petals close together at the throat, concealing the gynoeceum and with the anther bearing a small apical gland. (Species nos. 12 to 22).

5. *Acmadenia* section *Acmadenia* which is distinguished by having the flower with petals close together at the throat concealing the gynoeceum and with the anther crowned with a large conical gland. (Species nos. 23–30).

6. *Acmadenia* section *Albiflos* is distinguished by having flowers with snow-white petals, closed at the throat and fruits with carpels bifid at the apex. (Species nos. 31–33).

KEY TO THE SPECIES OF *ACMADENIA*

1	Leaves with glandular denticulate margins .....	2
1+	Leaves with margins ciliate or eciliate .....	4
2	Flowers with the stigma simple .....	<b>2. bodkinii</b>
2+	Flowers with the stigma capitate .....	3
3	Leaves flat on the adaxial surface .....	<b>3. macradenia</b>
3+	Leaves with a groove along the adaxial surface .....	<b>4. rourkeana</b>
4	Ovary 2-carpellate, fruit with carpels two-horned .....	<b>33. candida</b>
4+	Ovary 3 to 5-carpellate .....	5
5	Ovary 3 or 4-carpellate .....	6
5+	Ovary 5-carpellate .....	7
6	Ovary 3 or 4-carpellate, flower with the throat closed, fruit with carpels two-horned .....	<b>32. nivea</b>
6+	Ovary 4-carpellate, flowers with the throat open, fruit with carpels entire .....	<b>11. tetracarpellata</b>
7	Flowers distinctly coloured at the throat .....	<b>31. faucitincta</b>
7+	Flowers not distinctly coloured at the throat .....	8
8	Flowers standing open exposing the gynoeceum .....	9
8+	Flowers with the throat closed, petals bulged inwards at the claw ....	15
9	Leaves flat, flowers pedicellate .....	<b>1. flaccida</b>
9+	Leaves not flat, flowers sessile .....	10
10	Leaves terete, obtuse .....	<b>7. teretifolia</b>
10+	Leaves linear-lanceolate, oblong-linear, ovate, oblong or oblong- lanceolate; acute or obtuse .....	11
11	Style at some stage deflexed .....	12
11+	Style always erect .....	13
12	Flowers 9 mm diam., $\pm$ 5-nate .....	<b>5. wittebergensis</b>
12+	Flowers 13 mm diam., solitary .....	<b>6. tenax</b>

13	Petals white .....	<b>10. patentifolia</b>
13+	Petals pink or lilac .....	14
14	Petals pink, obovoid, narrowing evenly to the base ...	<b>8. matroosbergensis</b>
14+	Petals lilac, orbicular, narrow-clawed .....	<b>9. argillophila</b>
15	Anthers with a small globose or slightly pointed apical gland not more than 0,6 mm long .....	16
15+	Anthers with a large pointed apical gland more than 0,6 mm long ....	29
16	Fruits with horns about 4 mm long .....	<b>17. alternifolia</b>
16+	Fruits with horns not more than 1,5 mm long .....	17
17	Leaves alternate in mature plants .....	18
17+	Leaves opposite .....	22
18	Leaves elliptic, obtuse .....	<b>20. mundiana</b>
18+	Leaves lanceolate or linear-lanceolate, acute .....	19
19	Leaves with a pale white bristly apical callus .....	<b>18. kiwanensis</b>
19+	Leaves with a pale pink, red or brown glabrous apical callus .....	20
20	Leaves crisped ciliate .....	<b>19. densifolia</b>
20+	Leaves sparsely ciliate or scabrid ciliate .....	21
21	Leaves with a few minute black stalked glands on the adaxial surface, margins thick .....	<b>22. maculata</b>
21+	Leaves without any black stalked glands, margins thin .....	<b>21. obtusata</b>
22	Leaves elliptic .....	23
22+	Leaves lanceolate, linear-lanceolate or lanceolate-elliptic .....	24
23	Petals pubescent at the middle of the claw .....	<b>12. fruticosa</b>
23+	Petals pubescent at the sides of the claw .....	<b>24. heterophylla</b>
24	Petals glabrous at the throat .....	25
24+	Petals pubescent at the throat .....	27
25	Bracts 8 mm long .....	<b>13. burchellii</b>
25+	Bracts 2 mm long .....	26
26	Leaves linear-lanceolate, 1,5–2 mm broad .....	<b>14. trigona</b>
26+	Leaves lanceolate-elliptic, 4 mm broad .....	<b>15. latifolia</b>
27	Leaves lanceolate, obtuse, petals puberulous .....	<b>16. laxa</b>
27+	Leaves linear-lanceolate, acute, petals pubescent at the throat .....	28
28	Calyx lobes oblong obtuse .....	<b>21. obtusata</b>
28+	Calyx lobes narrowing evenly to an acute apex .....	<b>23. gracilis</b>
29	Leaves alternate in mature plants .....	30
29+	Leaves opposite .....	31
30	Calyx lobes narrowing evenly to an acute apex .....	<b>23. gracilis</b>
30+	Calyx lobes oblong, sub-acute .....	<b>25. rupicola</b>
31	Petals pubescent at the sides of the claw .....	<b>24. heterophylla</b>
31+	Petals pubescent at the middle of the claw .....	32
32	Leaves sub-orbicular when pressed flat .....	<b>30. tetragona</b>
32+	Leaves oblanceolate, oblong, lanceolate or linear-elliptic .....	33
33	Leaves oblanceolate, filament and staminodes sparsely pubescent .....	<b>29. baileyensis</b>
33+	Leaves oblong, lanceolate or linear-elliptic .....	34
34	Leaves oblong, filament and staminodes glabrous .....	<b>27. sheillae</b>
34+	Leaves lanceolate or linear-elliptic, adpressed erect .....	35
35	Leaves ciliate .....	<b>28. macropetala</b>
35+	Leaves crisped ciliate .....	<b>26. nivenii</b>

**1. ACMADENIA** sectio **MACROSTYLIODES** Williams, sect. nov.  
 propria propter carpella in quoque fructo unus vel duo solum maturescens.

Section *Macrostylioides* is distinguished by having only one or two carpels developing in each fruit.

Contains only one species:

1. ***Acmadenia flaccida*** Ecklon & Zeyher, Enum. Plant.: 105 (1835). Type: in terra ericeta (altit. II, III) montium prope Brackfontein (Clanwilliam), -/10/- Ecklon & Zeyher 823 (SAM, lectotype; C, G, K, P, S, W, isotypes).

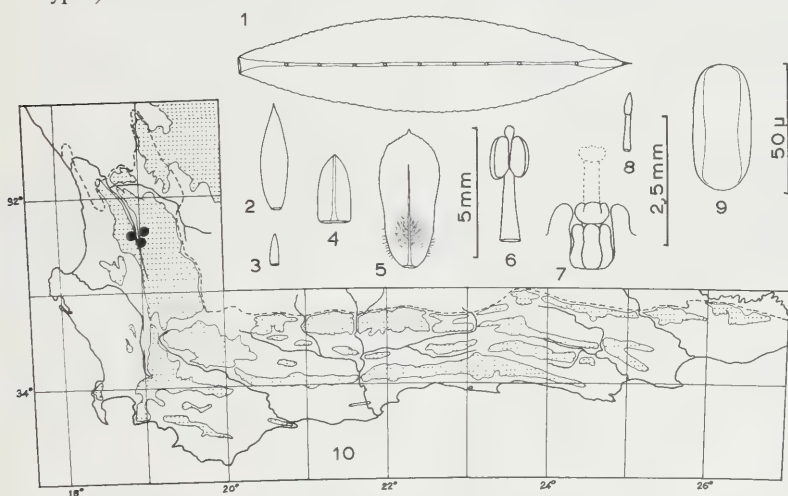


FIG. 2.

*Acmadenia flaccida*: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, anther. 7, gynoecium. 8, staminode. 9, pollen. 10, distribution.

*Shrubs* up to 1 m tall, slender, diffuse, single-stemmed at base. *Branches* few, dichotomous, rod-like, smooth, glabrous, brown, exocortex splitting off. *Branchlets* arising in pairs to either side of the main stem which terminates in an inflorescence, very slender, smooth, straight, glabrous, gland-dotted. *Leaves* up to 15 mm long, 3.7 mm broad, lanceolate, acute, mucronate, fairly flat, glabrous, glaucous, sessile, erect, opposite; margins crenulate, gland-dotted at the nodes, quite thick; midrib gland-dotted, gibbous behind the apex. *Inflorescence* terminal, up to 3 opposite pairs of flowers on a short peduncle; *flower* 7.5 mm diam., white, pedicellate, stands open. *Bract* 4 mm long, 1 mm broad, leaf-like. *Bracteoles* two, 1.2 mm long, 0.3 mm broad, leaf-like, much reduced, situated at the base of the pedicel. *Calyx lobes* five, 2.5 mm long, 1.3 mm broad, oblong, sub-acute, glabrous, glaucous, purplish towards the midrib, margins thin. *Petals* five, 3–5.3 mm long overall; *limb* 1.5–2.3 mm diam., orbicular, spreading; *claw* 1.5 mm



long, 1,1 mm broad, pubescent about the middle, sparsely ciliate towards the middle at the sides. *Staminodes* five, 0,5–1,1 mm long, with a conical gland at the apex, glabrous. *Filaments* five, becoming 0,9–1,6 mm long, subulate, glabrous. *Anthers* five, 0,75 mm long, 0,75 mm broad, pinkish-orange, apical gland with a long tapering point completely deflexed between the lobes of the anthers. *Pollen* 48–54  $\mu$  long, 22–25  $\mu$  broad, oblong. *Disc* obvallate, green, exudes nectar, equalling the stigma at first. *Stigma* 0,6 mm diam., capitate, flat on top, 5-lobed, green, glossy. *Style* becoming 1,2–1,3 mm long, erect, glabrous. *Ovary* 5-carpellate, 0,9 mm long, 0,8 mm diam., glabrous, apices globose. *Fruit* 5-carpellate, usually 4 aborted, 1 fertile, 12 mm long, 2,8 mm broad, glabrous, gland-dotted, pinkish; *horn* 5,5 mm long. *Seed* 5 mm long, 2,3 mm broad, black, matt; aril white.



FIG. 3.

*Acmadenia flaccida*: Paired flowers showing bearded petals, spent anthers and stigma.

*Acmadenia flaccida* was first collected, most probably, by Carl Zeyher who collected in the Clanwilliam district about 1829. Many duplicates of this collection were distributed under the joint names of Ecklon & Zeyher 183. A specimen housed in the herbarium of the South African Museum at Kirstenbosch has been chosen as the lectotype. It was not until nearly 100 years later in 1927 that this plant was again collected, this time by Dr. M. R. B. Levyns. The above description done from fresh material amplifies those previously given.

## SPECIMENS EXAMINED

CAPE—3218 (Clanwilliam): Haarwegskloof above Marcuskraal (not Brakfontein), Clanwilliam Division (-BD), 1 050 ft., 11/7/1975, *Williams 2015* (NBG).

—3219 (Wupperthal): in terra ericeta (altit. II, III) montium prope Brakfontein (Clanwilliam) (-AC), -/8/-, *Ecklon & Zeyher 823* (C, G, K, P, S, SAM, W); Nieuwoudt Pass. Cedarbergen, Clanwilliam Division, 7/9/1938, *Hafström & Acocks 791* (K, S); Algeria, Cedarberg, 1 500 ft., -/3/1928, *C.N. 349* (BM), 21/6/1942, *Esterhuysen 7850* (BOL, K, NBG, SAM), 2 000–2 500 ft., 30/8/1963, *Taylor 5080* (K, PRE, STE), 14/2/1936, *Compton 6249* (NBG), -/9/1927, *Levy's 2192* (SAM), 2 000 ft., 12/11/1969, *Taylor 7501* (STE), 2/8/1937, *Esterhuysen 723* (BOL); south west slopes of the Middelberg, Algeria, -/3/1940, *Esterhuysen 2522* (BOL, GRA, K); Middelberg, Cedarberg, 16/12/1941, *Esterhuysen 7289* (BOL); foot of Uitkyk Pass, 30/3/1956, *Esterhuysen 25556* (BOL); bottom of Cedarberg Pass, Algeria, 2 000 ft., 13/2/1973, *Williams 1760* (NBG).

## DISTRIBUTION

This species is very local. It is found at altitudes of between 320 and 600 m (1 000–2 000 ft.) in rather arid situations between Citrusdal and Clanwilliam near the Olifants river and near Algeria in the Cedarberg.

*Acmadenia flaccida* is recognised as distinct having staminodes 0.5–1.1 mm long, anthers with a large pointed deflexed apical gland, paired flowers and leaves large, flat, opposite, glabrous and glaucous.

**2. ACMADENIA** sectio **PELTATIGLANDULA** Williams, sect. nov. propria propter folio glandulo-denticulata.

Section *Peltatiglandula* is distinguished by having plants bearing glandular-denticulate leaves.

Contains species:

2. *A. bodkinii*
3. *A. macradenia*
4. *A. rourkeana*

**2. Acmadenia bodkinii** (Schltr.) Strid in Op. Bot. **32**: 101 (1972). Type: CAPE—3219 (Wupperthal): In montibus Cedarbergen prope montem Sneeuwkop et Wupperthal, Clanwilliam Division (-AC), 3 500–4 500 ft. alt., -/10/1897, *Bodkin s.n.* (BOL 8629, holotype).

*Adenandra bodkinii* Schltr. in Journ. Bot. **36**: 315 (1898). Type: as above.

*Shrubs* up to 0.7 m tall, usually much less, fairly erect, fairly well branched, single-stemmed at base. *Branches* short, more or less arising in clusters of 2 to 6, fairly erect, becoming glabrous; leaf scars not prominent. *Branchlets* short, erect, pubescent, bearing scattered stalked glands, well clothed with leaves. *Leaves* 7 mm long overall including the petiole 1.5 mm long, 3 mm broad, obovate, obtuse, alternate, sub-imbricate, adpressed towards the base, recurved above, sub-complicate; sparsely pubescent with occasional

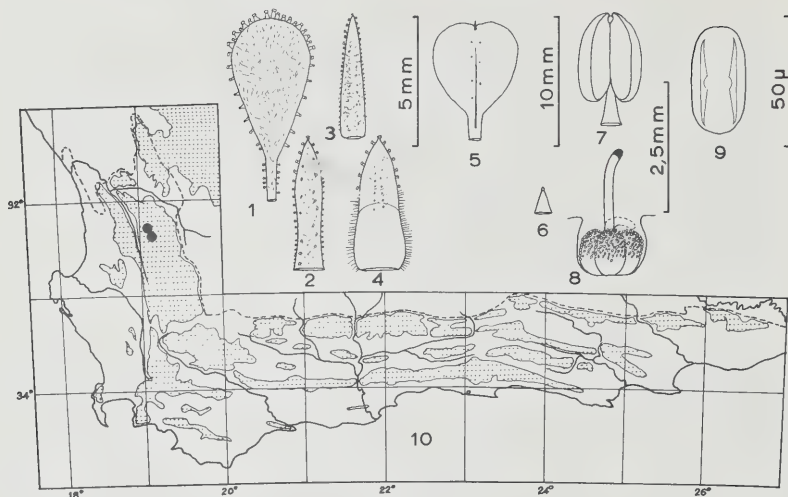


FIG. 4.

*Acmadenia bodkinii*: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, staminode. 7, anther. 8, gynoecium and disc. 9, pollen. 10, distribution.

stalked glands on both surfaces; margins glandular-dentate, apical gland much larger. *Inflorescence* solitary or twin, terminal; *flowers* 18 mm diam., petals whitish, spreading, with calyx lobes protruding between the petals. *Appendage*: at the apex of each branchlet, beside the flower and the other bud or incipient shoot, there is a terminal process which may be called a *caudal appendage* 4.5 mm long, terete, pubescent, reddened above with a discoid gland at the apex. *Bract* 5.2 mm long, 1 mm broad, linear-oblong, acute, white below, green above; midrib prominent; apex somewhat viscid with a discoid gland; margins with large stalked discoid glands above and many smaller ones below; adaxial surface pubescent; abaxial surface pubescent with erect hairs well spaced out and with small stalked glands scattered in between. *Bracteoles* two, 4.7 mm long, 1 mm broad, linear-lanceolate, acute, viscid, otherwise similar to the bract. *Calyx lobes* five, 5 mm long, 2 mm broad, lanceolate, acute, viscid; apex with a stalked discoid gland; margins above with 4–6 similar stalked glands to either side of the apex, below villous ciliate; sparsely pubescent on both surfaces mainly towards the apex, purplish above, distinctly veined below; midrib with stalked glands to either side. *Petals* five, 8.5–9 mm long overall; *limb* 6.5–7 mm long, 6.2–6.8 mm broad, obcordate, emarginate, apiculate, glabrous, white, spreading, minutely gland-dotted along the pink midrib; *claw* 2 mm long, 1 mm broad,

glabrous. *Staminodes* five, 0.5 mm long, deltoid, apex with a minute gland, glabrous, decurrent below buttressing the disc. *Filaments* five, becoming 1.2 mm long, narrowly deltoid, glabrous, decurrent below buttressing the disc after the manner of an *Adenandra*. *Anthers* five, 1.7 mm long, 1.2 mm broad, reddened; apical gland minute, clasped between the incurved apices of the thecae. *Pollen* 41  $\mu$  long, 21  $\mu$  broad, ellipsoid. *Disc* obvallate, exceeds the ovary, level above, reddened, exudes nectar. *Stigma* 0.2 mm diam., simple, dark purple. *Style* at first deflexed, becoming erect 1.6 mm long, glabrous. *Ovary* 5-carpellate, 0.9 mm long, 1.3 mm diam., densely covered with stalked glands. As the ovary develops it produces a most fantastic array of hairy stalked glands. *Fruit* 5-carpellate, each carpel 7 mm long, 3 mm broad, glabrous, clothed above with numerous erect processes with glandular apices and pubescent sides, the largest towards the apex. *Seed* 4 mm long overall, 1.8 mm broad, black, shining; aril somewhat canted over inwards.



FIG. 5.

*Acmadenia bodkinii*: flower with calyx lobes projecting above the petals.

This plant was transferred to *Acmadenia* by Strid as part of his revision of the genus *Adenandra*. As he remarked, it is "a very isolated species", but as it possesses staminodes and anthers with a minute apical gland and also having the filaments and style short, it would seem to fit well enough into the genus *Acmadenia*. The glandular dentate leaves place this plant in the section *Peltatiglandula* which includes two other most unusual species. The

above description done from fresh material may amplify those previously given.

#### SPECIMENS EXAMINED

CAPE—3219 (Wupperthal): in mont Cedarberg prope Sneeuwkop et Wupperthal, inter 3 500 et 4 500 ped. (-A.C.), -/10/1897, *Bodkin s.n.* (BOL 8629); near Crystal Pool, Cedarbergen, Clanwilliam Division, 4 400 ft., 22/9/1930, *Barnes s.n.* (BOL 19315), 25/6/1942, *Esterhuysen 7910* (BOL, K), 10/12/1965, *Dahlgren & Strid 4488* (NBG); Cedarberg below Sneeuwkop, plateau near Crystal Pool stream, 5 000 ft., 13/2/1973, *Williams 1761* (NBG), 7/10/1975, *Williams 2093* (NBG); rock crevices in massive rock on Scorpionsberg, north Cedarbergen, 5 000 ft., 26/10/1945, *Esterhuysen 12226* (BOL, NBG); Crevassberg, Cedarberg, rocky places, c. 5 000 ft., 1/6/1973, *Esterhuysen 33200* (BOL), 9/11/1969, *Taylor 7473* (STE), *Taylor 8454* (STE); rock crevices on peak at Koupoort, north Cedarberg, 4 000–5 000 ft., 22/10/1945, *Esterhuysen 12135* (BOL, NBG).

#### DISTRIBUTION

*Acmadenia bodkinii* is found growing at altitudes of between 1 200 and 1 500 m (4 000–5 000 ft.) in rock crevices in the Cedarberg in the vicinity of Crystal Pool, Scorpionsberg, Crevassberg and Koupoort a distance from north to south of only 11 km.

Of those species of *Acmadenia* with glandular denticulate leaves *A. bodkinii* is distinct in having the stigma simple and the anther with a minute gland clasped at the apex. It has leaves that are very much more pubescent than those of *A. macradenia* and which are flat on the adaxial surface without any groove as in *A. rourkeana*. The leaves even when dry have a strong smell of cedarwood oil.

**3. *Acmadenia macradenia*** (Sond.) Dümmer in Ann. Bol. Herb. 3 (2): 87 (1921). Type: In locis lapidosis (altit. III) laterum montium prope "Waterfall" vallis "Tulbagh" (Worcester), Dec., *Ecklon & Zeyher 789* (MEL, lectotype; S, TCD, isotypes).

*Adenandra macradenia* Sonder in Fl. Cap. 1: 389 (1860). Type: as above.

*Adenandra coriacea* Eckl. & Zeyh., Enum. Plant.: 100 (1835) non Licht. nec Roem. et Schult. Type: as above.

*Acmadenia macradenia* (Sond.) Dümmer. var. *borealis* Dümmer in Ann. Bol. Herb. 3 (2): 87 (1921). Type: Cape Province: South Western Region: Piquetberg Division, Piquetberg, Oct. 1895, *H. Bolus 8420* (BOL, holotype).

*Shrubs* 0.3–0.5 m tall, single-stemmed at base, dwarfed by the exposed conditions. *Branches* somewhat erect, fairly straight, rigid, glabrescent; bark smooth, dark brown. *Branchlets* fairly slender, erecto-patent, few, reddened as though varnished, sparsely villous, leafy. *Leaves* up to 15 mm long, 5.5 mm broad, decreasing in size towards the flowers to about 7 mm long, 3 mm broad, elliptic or oblong-elliptic, obtuse, spreading-erect, alternate; apex



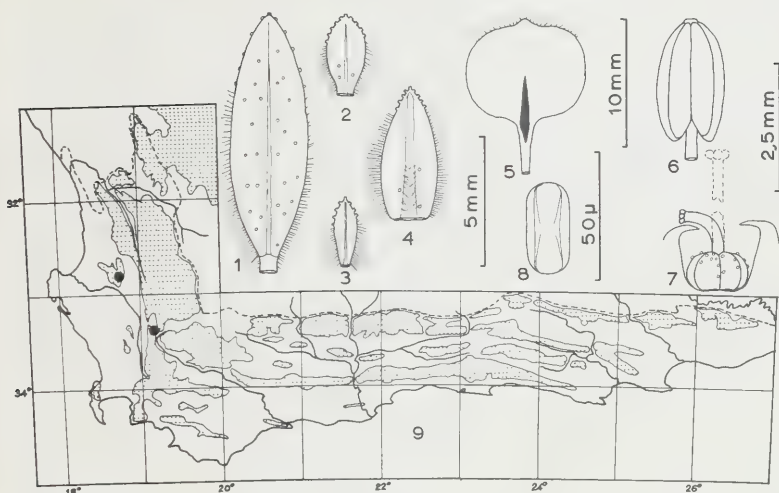


FIG. 6.

*Acmadenia macradenia*: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, anther. 7, gynoecium and disc. 8, pollen. 9, distribution.

with a raised discoid gland; margins thick glandular-denticulate towards the apex, laxly villous below and gland-dotted; narrowing at the base to a short petiole; adaxial surface smooth, flat, shining, glabrous; abaxial surface fairly flat with a slightly raised midrib and with scattered raised glands to either side. *Inflorescence* pedicellate, solitary or twin, at the ends of very short branchlets often found in small groups, white flushed with pink and having the appearance of an *Adenandra*. *Bract* one, 3–4 mm long, 1.5–2.5 mm broad, elliptic or orbicular, obtuse, glabrous, viscid, erect at base of pedicel; apex with a raised discoid gland; margins thick, glandular-denticulate above, villous below; abaxial surface with up to 3 raised glands. *Bracteoles* two, 2.6 mm long, 0.8 mm broad, oblanceolate, acute, glabrous, viscid, at base of pedicel; apex with a raised discoid gland; margins with raised glands towards the apex, villous below. *Pedicel* 5 mm long, villous. *Calyx lobes* five, 5 mm long, 2.2 mm broad, lanceolate, acute; apex with a raised discoid gland; margins thick with raised glands towards the apex, villous below; abaxial surface glabrous with 2 or 3 raised glands in the lower half; midrib villous. The erect glandular apices project upwards between the petals within the flower. *Petals* five, 12 mm long overall; *limb* 8 mm long, 9.2 mm broad, sub-orbicular, obtuse-apiculate, villous ciliate above; adaxial surface white, midrib with a flash of red at the throat; abaxial surface reddened becoming somewhat pink

towards the midrib; *claw* glabrous, very narrow. *Staminodes* five, vestigial, the disc with an obtuse apex at this point, more easily visible in dried material as a small withered point about 0,1 to 0,2 mm long. *Filaments* five, becoming 2 mm long, 0,3 mm diam., stout, erect, acicular, purplish or wine-coloured, glabrous. *Anthers* five, before anthesis 2,4 mm long, 1,3 mm broad, wine-coloured, truncate at the apex without any apparent gland; when dry a sessile semi-globose gland 0,1 diam., is visible. *Disc* exceeds the ovary by a long way, closing somewhat over it, dark green, flattened above, exudes nectar. *Pollen* 35  $\mu$  long, 17  $\mu$  broad, oblong. *Stigma* 5-lobed, each lobe somewhat globose, 0,5 mm diam., capitate, pale green. *Style* at first deflexed, becoming erect, 2,5 mm long, glabrous. *Ovary* 5-carpellate, 0,7 mm long, 1,2 mm diam., apices bearing raised glands. *Fruit* 5-carpellate, 8,5 mm long overall, 6 mm diam.; *carpels* glabrous, shining, sparsely scattered with raised glands; *horns* spreading-erect, adaxially canaliculate, glabrous. *Seed* not seen.

Having been collected in December, specimens of this plant distributed by Ecklon and Zeyher (under the mistaken name of *Adenandra coriacea*) were without flowers, with the result that Sonder, in writing it up for the *Flora Capensis*, saw fit to place it in the genus *Adenandra* as *Adenandra macradenia*.

A fragment in bloom collected by Bolus in October 1895 on the Piquetberg was examined by R. A. Dümmer who assigned it to the genus *Acmadenia* proposing the new combination *Acmadenia macradenia* and at the same time describing Bolus's plant as a variety.

However, specimens of *A. macradenia* recently collected in the Kluitjieskraal Forest Reserve near Wolseley exactly match the fragment collected by Bolus and so the name *A. macradenia* var. *borealis* has been reduced to synonymy. The above description done from fresh material amplifies those previously given which were based upon a few very fragmentary specimens.

#### SPECIMENS EXAMINED

CAPE—3218 (Clanwilliam): Piquetberg, -/10/1895, *H. Bolus* 8420 (BOL). —3319 (Worcester): In locis lapidosis laterum montium prope "Waterfall" vallis "Tulbagh" (-AC), Altit III, -/12/-, *Ecklon & Zeyher* 789 (MEL, S, SAM, TCD); Kluitjieskraal Forest, summit of pass over Watervalsberg, Wolseley, 2 000 ft. alt., 1/9/1973, *Williams* 1863 (NBG), 8/11/1974, *Williams* 1924 (NBG), 20/10/1960, *van Breda* 1054 (PRE); St Sebastians Kloof and environs on crest of ridge, exposed on top of rocks, specimen only one visible, 2 500 ft. alt., -/9/1939, *Stokoe* 7096 (BOL).

#### DISTRIBUTION

From the very few collections ever made of this species it would appear to be confined to the summits of rocky ridges in the mountains to the west of Wolseley. The single collection of a mere fragment from the Piquetberg by

H. Bolus in 1895 has never been repeated or confirmed and represents a possible disjunction of about 75 km in the distribution of this species.

*Acmadenia macradenia* with glandular-denticulate leaves, pedicellate flowers, vestigial staminodes and with anthers truncate at the apex is a most distinct species. Having leaves that are fairly flat with the midrib not very prominent make it easily distinguished from *Acmadenia rourkeana* which has leaves with a prominent midrib and the adaxial surface longitudinally grooved. The leaves when crushed have a strong smell reminiscent of scented verbena or of *Eucalyptus citriodora*.

**4. *Acmadenia rourkeana* Williams, sp. nov.** earum follis glandulodenticulatis et floribus pedicellatis propria propter folia nervo medio prominenti et pagino adaxiali sulcato.

*Frutex humilis, ad basim ramulosis. Rami brevi, graciles, nigrescentes, glabrescentes. Ramuli brevi, graciles, sparsim villosi, foliosi. Folia 6–8,8 mm*

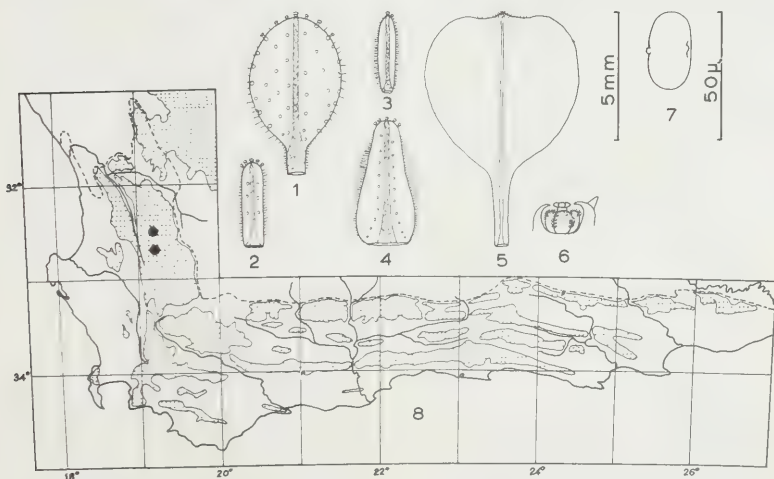


FIG. 7.

*Acmadenia rourkeana*: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, gynoecium and disc. 7, pollen. 8, distribution.

longa (petiolo 1 mm longo incluso), 3–4,3 mm lata, elliptica, alterna, erecto-patentia; apex obtusis, peltato-glandulosus; margines crassi, sparsim villosociliati, glandulodenticulati; pagina adaxialis sulcata, sparsim villosa; pagina abaxialis glanduloso-punctata nervo medio prominenti, sparsim villosa. *Inflorescentia* terminalia, solitaria, pedicellata. *Bractea* imo pedicello, 3,3 mm

longa, 0,8 mm lata, linearis, obtusa, apex versus 5-stipitato-glandulosa, ciliata, costa puberula. *Bracteolae* duae, imo pedicello, 3 mm longae, 0,7 mm latae, lineares, obtusae, ciliatae, apice glanduloso, costa puberula. *Sepala* quinque, 4,8 mm longa, 2–2,3 mm lata, lanceolata, obtusa; apex versus 5–7-stipitato-glandulosa, petala excedentia marginibus ciliatis, nervo medio prominenti puberulo stipitato-glanduloso. *Petala* quinque, 9 mm longa in toto; limbus 6 mm lata, sub-orbicularis, apex versus ciliata; *unguis* 3 mm longus, 0,6 mm latus, glaber. *Staminodia* quinque, 0,3–0,5 mm longa, deltoidea, glandula c. 0,1 mm diam., coronata. *Filamenta* quinque, 1 mm longa, subulata, vinosa, glabra. *Antherae* quinque, c. 1,1 mm longae, oblongae, vinosae, glandula 0–0,1 mm longa, coronata. *Pollen* 30  $\mu$  longum, 17  $\mu$  latum, ellipsoideum. *Discus* ovarium includens, vinosus. *Stigma* 5-lobatum, 0,4–0,7 mm diam., discoidea. *Stylus* 0,5 mm longus, glaber, erectus. *Ovarium* 5-carpellatum, 0,8 mm longum, 1,3 mm diam., apicibus pubescentis, lateribus peltato-glandulosis. *Fructus* 5-carpellatus, 6 mm longus, 5 mm diam., viridus, puberulus, lateribus peltato-glandulosis; *cornua* 1,5 mm longa, echinulata, vinosa, erecta. *Semen* 3,2–4,3 mm longum, 1,7–1 mm latum, piceum, nitens.

*Type*: CAPE—3219 (Wupperthal): near Sneeuwberg hut, South Cedarberg, Clanwilliam Division (-AC), 3 500–4 000 ft. alt., 31/8/1963, *Esterhuysen* 30285 (BOL, holotype).

*Shrubs* low, much branched at base, developing long branches where mingling with taller shrubs, growing from rock crevices or amongst rocks. *Branches* slender, short, glabrescent, becoming almost black. *Branchlets* very slender, short, sparsely villous, leafy. *Leaves* 6–8,8 mm long, 3–4,3 mm broad, elliptic, alternate, spreading-erect; apex obtuse with a peltate gland; margins somewhat recurved, sparsely villous, gland-dotted and with about 6 peltate glands to either side of the apex; adaxial surface flat, sparsely villous, with a groove up the middle; abaxial surface with scattered raised glands; midrib villous, prominent. *Inflorescence* terminal, solitary or occasionally pseudo-paired; *pedicel* 7–20 mm long, villous with scattered peltate glands. *Bract* one at the base of the pedicel, 3,3 mm long, 0,8 mm broad, linear, obtuse with 5 peltate glands at the apex, ciliate; midrib puberulous with 3 peltate glands to either side. *Bracteoles* two at the base of the pedicel, 3 mm long, 0,7 mm broad, linear, obtuse with peltate glands at the apex, ciliate; midrib puberulous with 1–2 minute peltate glands. *Calyx lobes* five, 4,8 mm long, 2–2,3 mm broad, lanceolate, obtuse with 5–7 peltate glands at the apex, ciliate, wine-coloured above and projecting between the petals; midrib raised, puberulous with minute peltate glands to either side. *Petals* five, 9 mm long overall, white except at the midrib and throat where pink; *limb* 6 mm long, 6 mm broad, sub-orbicular, villous ciliate towards the apex; *claw* 3 mm long, 0,6 mm broad. *Staminodes* five, 0,3–0,5 mm long, conical, wine-

coloured, apical gland c. 0.1 mm diam. *Filaments* five, 1 mm long, subulate, glabrous, wine-coloured. *Anthers* five, c. 1.1 mm long, oblong, wine-coloured; apical gland minute, 0–0.1 mm long, very hard to see. *Pollen* 30  $\mu$  long, 17  $\mu$  broad, ellipsoid. *Disc* exceeds the ovary and closes over it, flat on top, wine-coloured. *Stigma* 5-lobed, 0.4–0.7 mm diam., discoid, capitate. *Style* 0.5 mm long, erect, persistent, glabrous. *Ovary* 5-carpellate, 0.8 mm long, 1.3 mm broad; carpels pubescent at the apices, with peltate glands at the sides. *Fruit* 5-carpellate, 6 mm long, 5 mm diam.; carpels puberulous with peltate glands towards the sides, pubescent along the apical suture; *horns* 1.5 mm long, erect, oblong, echinulate, dark-reddened. *Seed* 3.2–4.3 mm long, 1.7–2 mm broad, black, shining.

*Acmadenia rourkeana* was apparently first collected both by Professor R. H. Compton and by Dr Joyce Lewis in September 1936 in the Elandskloof Mountains between Ceres and Citrusdal, a very adventurous road in those days. It remained unidentified for many years until mistakenly named *Acmadenia macradenia* to which species it bears some resemblance.

#### SPECIMENS EXAMINED

CAPE—3219 (Wupperthal): Slangvlei, Cedarberg (-AC), *Andrag* 260 (STE); near Sneeuwberg hut, South Cedarberg, Clanwilliam Division, 3 500–4 000 ft. alt., 31/8/1963, *Esterhuysen* 30285 (BOL), 4 150–4 350 ft., 30/11/1976, *Williams* 2245 (NBG); rugged slopes east side of Sneeuwberg, south Cedarbergen, 4 000 ft., 11/10/1946, *Esterhuysen* 13090 (BOL); slopes below Apollo peak, south Cedarbergen, 4 000 ft., 13/12/1950, *Esterhuysen* 18041 (BOL); Duivelskloof, Cedarberg, -/9/1950, *Stokoe s.n.* (SAM 64180); Elandskloof, Ceres/Clanwilliam Division, 26/9/1936, *Lewis s.n.* (BOL 22051), 3/10/1940, *Bond* 637 (NBG); Elandskloof Mtns., 4 000 ft., 25/9/1936, *Compton* 6559 (NBG); Elandskloof, on south slope amongst rocks, 4 000 ft., 3/10/1940, *Esterhuysen* 3153 (BOL, GRA, SAM); in sheltered rock crevice, 3 000 ft., 3/10/1940, *Esterhuysen* 3154 (BOL, GRA, K).

#### DISTRIBUTION

*Acmadenia rourkeana* is found growing amongst rocks at altitudes of from about 900 to 1 200 metres (3 000–5 000 ft.) in the mountains to the east of Citrusdal in the Clanwilliam Division.

Of those species of *Acmadenia* with glandular-denticulate leaves *Acmadenia rourkeana* is recognised as distinct having leaves with a groove running up the middle of the adaxial surface and with the midrib prominent. It differs from *A. macradenia* which has leaves more glabrous and flat without any groove on the adaxial surface, with the midrib not so prominent and with the raised glands not so much stalked. It differs from *A. bodkinii* which has the flowers sessile and not pedicellate and leaves without any groove on the adaxial surface, much more pubescent and with margins much more glandular-denticulate. The leaves when crushed have a very faint rich nutty smell.



This species has been named in honour of Dr J. P. Rourke, Curator of the Compton Herbarium at Kirstenbosch, who has for many years been a good friend giving great help and encouragement to me in my work.

**3. ACMADENIA** sectio **PATENTIPETALUM** Williams, sect. nov. propria propter petalia patentes omnibus expositis.

Section *Patentipetalum* is distinguished by having the petals spreading, revealing the anthers and gynoecium.

Contains species:

5. *A. wittebergensis*
6. *A. tenax*
7. *A. teretifolia*
8. *A. matroosbergensis*
9. *A. argillophila*
10. *A. patentifolia*
11. *A. tetracarpellata*

**5. *Acmadenia wittebergensis*** (Compton) Williams in JI S. Afr. Bot **44** (4): 359 (1978). Type: CAPE—3320 (Montagu): Witteberg (Whitehill), south slope, Laingsburg Division (-BC), 1067 m (3 500 ft.), 11/8/1924, *Compton* 2524 (BOL, lectotype).

*Diosma wittebergensis* Compton in Trans. R. Soc. S. Afr. **19**(3): 297 (1931). Type: as above.

*Acmadenia wittebergensis* is recognised as being distinct because of having thick pointed crowded leaves, pubescent bracts, bracteoles and calyx lobes, short conical staminodes with conical glands on the anthers and a multi-stemmed habit. It is perhaps nearest to *A. teretifolia* which however has much shorter obtuse leaves.

**6. *Acmadenia tenax*** Williams in JI S. Afr. Bot **45**(2): 166 (1979). Type: CAPE—3319 (Worcester): uppermost left-hand fork of Jan du Toits Kloof, Hex River Mountains; near Mount Brodie, Worcester Division (-AD/CB), 1 646 m (5 400 ft.), 18/2/1978, *Esterhuysen* 34852 (BOL, holotype; E, K, L, LD, M, MO, NBG, PRE, S, isotypes).

*Acmadenia tenax* is recognised as distinct because of being a tough, glabrous plant growing on cliffs, with relatively large white flowers, having anthers with a small sessile globose apical gland and a style at first deflexed, the fruit glabrous with horns 3–5 mm long. Only three other species of *Acmadenia* have the style deflexed at first, *A. teretifolia*, *A. tetracarpellata* and *A. wittebergensis*, but all of these have fruits with truncated or very short horns. Of all the species of *Acmadenia* with white flowers, *A. tenax* has the largest petals.

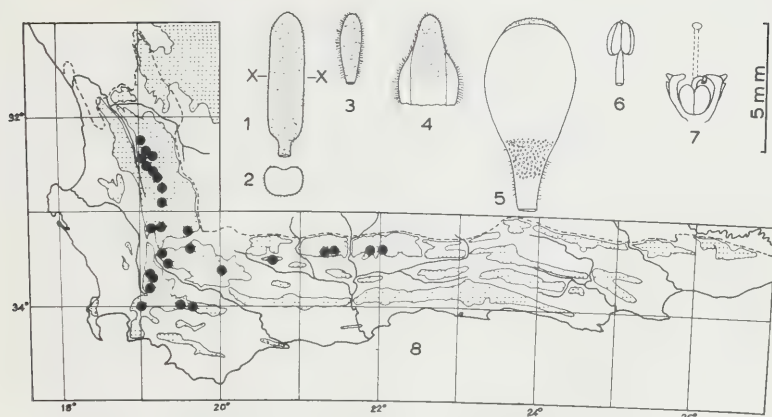


FIG. 8.

*Acmadenia teretifolia*: 1, leaf. 2, section of leaf. 3, bracteole. 4, calyx lobe. 5, petal. 6, anther. 7, gynoecium.

**7. *Acmadenia teretifolia* (Link) Phillips** in Kew Bull.: 23 (1920). Type: *Diosma ferulacea*, Kew, 1815 (GOET, lectotype).

*Diosma teretifolia* Link, Enum. Plant.: 237 (1821). Type: as above.

*Acmadenia teretifolia* (Link) Dümmer in Ann. Bol. Herb. 3(2): 87 (1921). nom. superfl.

*Acmadenia teretifolia* (Link) Phillips var. *glabrata* (Sond.) Phillips in Kew Bull.: 23 (1920).

*Acmadenia teretifolia* (Link) Dümmer var. *glabrata* (Sond.) Dümmer in Ann. Bol. Herb. 3(2): 88 (1921). nom. superfl.

*Diosma teretifolia* Link var. *glabrata* Sonder in Fl. Cap. 1. 376 (1860).

*Diosma ferulacea* Hort. Kew. nom. nud.

*Shrubs* up to 0,4 m tall, dense, sprawling, with many stems arising from a stout root growing in crevices in massive T.M.S. rocks. *Branches* numerous, spreading, short, brown, glabrous, roughened with leaf scars. *Branchlets* fairly erect, slender, short, numerous, thinly puberulous. *Leaves* 5 mm long, 1,3–1,5 mm broad, sub-terete, obtuse, at first puberulous becoming glabrous, somewhat erect, alternate, crowded, abruptly narrowing below to a petiole 0,6 mm long; apex with an immersed callus; adaxially flattened-canaliculate; abaxially rounded, without margins or midrib, gland-dotted. *Inflorescence* terminal, 2–3 nate, sessile, stands open, subtended by a leaf-like bract. *Bracteoles* two, 2,7 mm long, 0,8 mm broad, leaf-like, ciliolate, adaxially flattened, abaxially sparsely puberulous. *Calyx lobes* five, 3,5 mm long, 2,3 mm broad, broadly, lanceolate, thinly puberulous, ciliate; apex obtuse,

thickened, reddish; margins translucent below. *Petals* five, spreading, about 7,5 mm long, 3,5 mm broad, ovate, pink, apex curled inwards and sparsely puberulous abaxially, narrowing below; *claw* 0,7 mm wide at base, adaxially papillöse, margins sparsely ciliolate. *Staminodes* five, small glands c. 0,2 mm diam., pointing outwards at 45°. *Filaments* five, 1 mm long, glabrous, acicular. *Anthers* five, before anthesis 1,3 mm long, 0,9 mm broad; apical gland 0,1 mm long. *Pollen* 42  $\mu$  long, 20  $\mu$  broad, oblong. *Disc* obvallate, slightly curled inwards, exceeds the ovary, exudes nectar. *Stigma* 0,4 mm diam., capitate. *Style* at first deflexed, becoming erect, 2,7 mm long, glabrous, slender. *Ovary* 5-carpellate, 1,2 mm diam., apices puberulous. *Fruit* 5-carpellate, 6,5 mm diam., globose without horns; carpels glabrous, gland-dotted; apices emarginate, sparsely puberulous. *Seed* 4,1 mm long, 2 mm broad, black, shining; aril black.



FIG. 9.

*Acmadenia teretifolia*: flower showing disc and staminodes.

In his list of plants growing in the Royal Botanic Gardens at Berlin, published in 1821, Dr H. F. Link gives the source of his material as *Hort. angl.* meaning that he obtained his plant from the Royal Botanic Gardens at Kew. He also mentions that it had not yet flowered. The type in Link's

herbarium at Berlin was destroyed by fire during the 1939/45 war. However, a fragment, without flowers, preserved in the herbarium at Göttingen and labelled *Diosma ferulacea*, Kew, 1815, would appear to be part of the type material. It has been selected as the lectotype. This plant has leaves that are so distinctive that there can be no mistaking the species and, as an additional clue, the manuscript name given at Kew, *ferulacea* means *fennel like* referring to the smell of the leaves when crushed. The leaves of this plant have a very strong smell of liquorice or perhaps aniseed when crushed. The above description amplifies those already given by previous authors.

#### SPECIMENS EXAMINED

CAPE—3219 (Wupperthal): Krakadouw Peak, Cedarberg, Clanwilliam Division (-AA), 5 700 ft., 30/12/1941, *Esterhuysen* 7491 (BOL), 5 000 ft., 26/10/1923, *Pocock* 666 (STE), -/1/1942, *Stokoe* s.n. (NBG, SAM 59378); Sneeuwkop summit, Cedarberg, Clanwilliam Division (-AC), 6 300 ft., 13/10/1923, *Pocock* 215 (STE), 6 000 ft., 12/2/1936, *Compton* 6247 (NBG), 6 200 ft., -/12/1941, *Stokoe* s.n. (SAM 59376), 6 360 ft., -/2/-, *Leipoldt* 651 (BOL, GRA, SAM), 6 000 ft., 2/1/1942, *Esterhuysen* 7575 (BOL); Langberg, Cedarberg, Clanwilliam Division, 6 200 ft., 15/12/1941, *Bond* 1382 (NBG), 6 100 ft., 24/1/1963, *Rycroft* 2622 (NBG), 6 100 ft., 15/2/1973, *Williams* 1766 (NBG), 6 000 ft., 15/12/1941, *Esterhuysen* 7318 (BOL); Suurvleiberg summit, Cedarberg, Clanwilliam Division, -/3/1940, *Esterhuysen* 2554 (BOL, GRA); prope Wupperthal, -/10/1897, *Bodkin* s.n. (BOL 8957, K); plateau south of Tafelberg, Cedarberg, 5 000 ft., 29/12/1962, *Esterhuysen* 29999a (BOL); Apex Peak, South Cedarberg, Clanwilliam Division (-CA), 5 000 ft., 1/4/1961, *Esterhuysen* 28976 (BOL); Sneeuwberg, summit, South Cedarberg, 6 600 ft., 1/3/1947, *Esterhuysen* 13833 (BOL), 6 000–6 600 ft., 1/9/1963, *Taylor* 5089a (PRE), 6 500 ft., 16/5/1966, *Taylor* 6824 (STE), 22/7/1972, *Andrag* 1110 (STE); Donkerkloofkop, S. Cedarberg, Clanwilliam Division, -/9/1950, *Stokoe* s.n. (SAM), 6 000 ft., -/1/1944, *Stokoe* 9148 (BOL, SAM); Top of Heksberg, -/3/1951, *Stokoe* s.n. (SAM 65570); Kafferkop Summit northern Cold Bokkeveld, 4 760 ft., 8/3/1973, *Williams* 1772 (NBG); Sandfontein, South Cedarberg, Ceres Division (-CB), 5 000 ft., 6/4/1953, *Esterhuysen* 21318 (BOL); Gideonskop, 5 000 ft., 6/4/1947, *Esterhuysen* 13885 (BOL); Blaauwkoop, Cold Bokkeveld, Ceres Division, 5 500 ft., to summit, 1/10/1958, *Esterhuysen* s.n. (BOL); Schoongezicht Peak, Ceres Division (-CC), 4 400 ft., -/4/1939, *Stokoe* 7677 (BOL); Cold Bokkeveld Tafelberg, Ceres Division (-CD), 6 200 ft., 22/1/1897, *Schlechter* 10098 (BM, G, GRA, K, BOL, P, PRE, SAM, W), 8/12/1940, *Bond* 694 (NBG), 8/12/1940, *Esterhuysen* 3924 (BOL); Schurveberg summit above Excelsior, Cold Bokkeveld, Ceres Division, 4 958 ft., 8/12/1976, *Williams* 2258 (NBG), 1/1/1962, *Esterhuysen* 29434 (BOL, PRE).

—3319 (Worcester): Ad montem Winterhoeksberg prope Tulbagh (-AA), *Ecklon* & *Zeyher* 827 (MEL, S), 1 100 m, 2/1/1887, *Marloth* 1650 (PRE), 6/12/1896, *A. Bolus* s.n. (BOL); Sneeuwgat Peak, Great Winterhoek Peak, summit, 6 000 ft., 30/12/1951, *Esterhuysen* 19758 (BOL); Little Winterhoek Mountain, -/4/1926, *Stokoe* s.n. (BOL); Hansiesberg, Cold Bokkeveld, Ceres Division (-AB), 6 000 ft., 17/12/1944, *Compton* 16704 (NBG), 17/12/1967, *Jackson* s.n. (NBG), 18/4/1956, *Esterhuysen* 25757 (BOL); Skurfdebergen, Gydouw, Ceres Division, -/12/1891, *H. Bolus* 7576 (BOL); Mostertshoek Twins (-AD), 6 500 ft., 8/1/1944, *Wasserfall* 783 (NBG), *Esterhuysen* 9857 (BOL); Buffelshoek Peak, Hex River Mountains, 6 500 ft., 26/12/1942, *Esterhuysen* 8411 (BOL); Baviaansberg, west of Karroopoort, Ceres Division (-BA), 6 000 ft., 4/11/1962, *Esterhuysen* 29807 (BOL); Matroosberg, Ceres Division

(-BC), -1/1941, *Stokoe s.n.* (G, SAM 30583), 2 200 m, -/5/1894, *Marloth 1995* (PRE), 7 000 ft., -/1/1917, *Phillips 1968* (K, SAM), 5 000-6 500 ft., 7/4/1958, *Esterhuysen 27722* (BOL), 2 000 m, -/1/1897, *Marloth 2343* (BOL, GRA, PRE, SAM), 7 400 ft., 2/1/1897, *A. Bolus s.n.* (BOL 6360, K, NBG 4393), -/12/1895, *A. Bolus s.n.* (BOL 3968), 2 100 m, 2/1/1897, *Marloth 2367* (STE), 2 200 m, -/12/1895, *Marloth 2280* (STE); Slanghek Pile summit, Worcester Division (-CA), 5 000 ft., -/1/1940, *Esterhuysen 1731* (BOL); Witteberg summit, 6 000 ft., 9/2/1943, *Esterhuysen 8691* (BOL); Dutoitskloof in Slanghoek, (III,A,e,10), 2 500-3 000 ft., 29/2/1828 *Drège s.n.* (P); Dutoitskloofberge near Wagemakersvlei, (III,A,e,10), 2 500-3 000 ft., 10/1/1828, *Drège s.n.* (G, K, P 1877, W); Slanghoek Peak summit, 5 000 ft., 17/1/1969, *Jackson s.n.* (NBG); Dutoits Peak summit, Worcester Division (-CC), 2 000 m, -/1/1899, *Marloth 9376* (PRE), 6 700 ft., 26/1/1943, *Esterhuysen 8579* (BOL); Wemmershoek near beacon, -/9/1939, *Stokoe 7144* (BOL); Wildepaardeberg, Worcester Division (-DC), -/2/1936, *Stokoe s.n.* (BOL).  
 —3419 (Caledon): Galgeberg, Robertson Division (-BA), 4 300 ft., 23/3/1972, *Williams 1630* (NBG).  
 —3320 (Montagu): Pypsteelfontein, Waboomsberg, Montagu Division (-CA), 4 400 ft., 5/2/1975, *Williams 1968* (NBG); Leeuwriewierberg, Swellendam Division (-CD), 5 300 ft., -/4/1941, *Stokoe s.n.* (SAM 59377, BOL); Anysberg, rocky summit, Laingsberg/Ladismith Division (-DA), 21/5/1950, *Esterhuysen 17065*.  
 —3321 (Ladismith): Towerkop, Swartbergen, Ladismith Division (-AC), 7 200 ft., 5/9/1947, *Esterhuysen 13933* (BOL); Swartberg above Kliphuisvlei summit ridge (-BD), 1 980 m, 1/1/1975, *Oliver 5527* (STE); Seven Weeks Poort Mountain (-AD), 6 000-7 600 ft., 21/8/1956, *Wurts 1470* (NBG), 2 300 m, 26/12/1928, *Andreae 1188* (PRE), 7 600 ft., 30/3/1959, *Esterhuysen 28273* (BOL).  
 —3322 (Oudtshoorn): Swartberg Pass, rocky summit of range (-AC), 5 800 ft., 29/1/1961, *Esterhuysen 28829* (BOL), 6 000 ft., 25/1/1941, *Esterhuysen 4512* (BOL, GRA, SAM).

Without precise locality: *Roxburgh 14* (BM), *Niven 17* (BM, GOET), *Wallich s.n.* (BM, G, BOL, K, PRE), *Diosma ferulacea Kew 1815* (GOET).

## DISTRIBUTION AND VARIATION

*Acmadenia teretifolia* is found only at very high altitudes, right up to and often on the summits of the highest peaks. Its known distribution extends from the Krakadouwsberg in the north near Clanwilliam more or less due south to the Drakenstein Mountains in the south and in an easterly direction more or less in line with Ceres to the vicinity of the Swartberg Pass near Oudtshoorn.

Although Sonder (1860) recognised a more glabrous plant at varietal level this difference with all the evidence now to hand cannot be upheld. Some variation in leaf size has been noticed, particularly in the thickness of the leaves and some populations from the Swartberg area appear to have smaller leaves.

*Acmadenia teretifolia* is readily recognised as distinct on account of having sub-terete leaves rounded at the apex and narrowing abruptly below to a slender petiole. It is perhaps nearest to *A. matroosbergensis* which however has leaves oblong-linear, sub-acute, sessile and very variable in size.



**8. *Acmadenia matroosbergensis*** Phillips in Jl S. Afr. Bot. **9** (3): 137 (1943).

Type: Cape Province: Matroosberg, 1 900 m, 30/9/1924, *Marloth 7949* (BOL, lectotype; PRE, STE, isotypes).

*Diosma marlothii* Dümmer in Ann. Bol. Herb. **3**(1): 1 (1921). Type: Cape Province: probably on the Matroosberg, R. *Marloth 7949* (Herb. Marloth).

Icon: M. M. Page in Ann. Bol. Herb. **3**(1): 66, plate 1, D (1921).

*Shrubs* up to 0,6 m tall, single-stemmed at base. *Leaves* to 8,5 mm long, 1,5 mm broad, very variable in size, oblong linear, sub-acute, mucronate, glabrous, erect, usually opposite, decussate; adaxial surface concave; abaxial surface rounded, gland dots scattered; margins scabrid. *Inflorescence* termin-

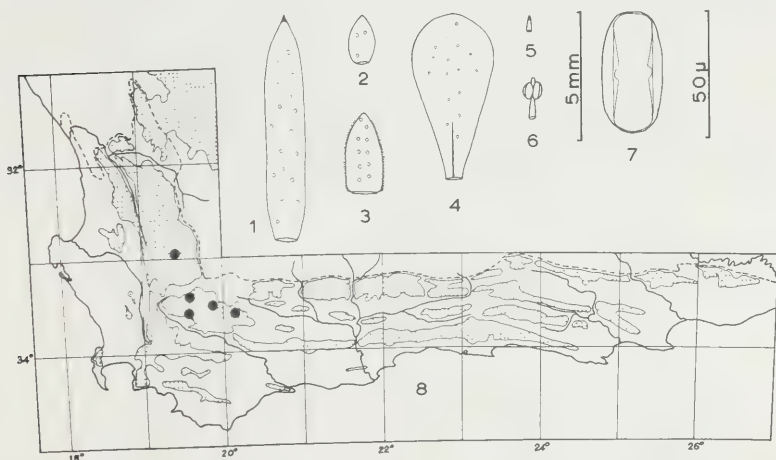


FIG. 10.

*Acmadenia matroosbergensis*: 1, leaf. 2, bracteole. 3, calyx lobe. 4, petal. 5, staminal node. 6, anther. 7, pollen. 8, distribution.

al in pairs, sessile, stands open, pink, 12 mm diam. *Bract* somewhat leaf-like. *Bracteoles* two, 1,8 mm long, 1 mm broad, elliptic, glabrous, sessile with a few gland dots; apex with a small obtuse point; margins translucent, ciliolate. *Calyx lobes* five, 3 mm long, 1,5 mm broad, oblong-lanceolate, obtuse, glabrous, gland-dotted in two rows; margins translucent, ciliolate. *Petals* five, 6,5 mm long, 3,2 mm broad, ob-ovoid, narrowing evenly to the base, gland-dotted, glabrous, minutely and sparsely ciliolate, spreading widely and recurved. *Staminodes* five, 0,5 mm long, with a minute, pale, acute apical gland, reddened, glabrous. *Filaments* five, 1,1 mm long, acicular, reddened, glabrous. *Anthers* five, 0,7 mm diam., dark maroon in colour;

apical gland 0,3 mm diam., acute, sticky. *Pollen* 47  $\mu$  long, 23  $\mu$  broad, oblong. *Disc* exceeding the ovary and folding slightly over it, turgid, dark red, exuding nectar. *Stigma* 0,4 mm diam., capitate, dark red. *Style* becoming 1 mm long, erect, glabrous, reddened. *Ovary* 5-carpellate, 1 mm diam., glabrous; apices globose, turgid. *Fruit* 6,5 mm long, 7,5 mm diam., glabrous, hornless, multi-gland-dotted, with an immersed gland at the apex of each carpel. *Seed* 4,5 mm long, 2,2–2,4 mm broad, black, shining, rather more pointed at one end than usual; aril white.

Dümmer stated that his description was based on five specimens in Dr Marloth's Herbarium, without exact particulars as to place or date of collection. However, a duplicate in the National Herbarium at Pretoria gives the



FIG. 11.  
*Acmadenia matroosbergensis*: flower and flower bud.

locality altitude and date of collection and these have been given above. The specimen at the Bolus Herbarium having most likely been seen by Dümmer has been chosen as the lectotype. The above description amplifies that previously given.

#### SPECIMENS EXAMINED

CAPE—3219 (Wupperthal): Schurweberg, Cold Bokkeveld, Ceres Division (-CD), 4 000–4 500 ft., 11/10/1952, *Esterhuysen* 20622 (BOL, K, LD, NBG), 4 800–4 950 ft., 8/12/1976, *Williams* 2257 (NBG); Schurweberg, above Excelsio, 4 500 ft., 5/8/1971, *Esterhuysen* 32615 (BOL).  
—3319 (Worcester): Matroosberg (-BC), 1 900 m, 2/10/1899, *Marloth* 7949 (BOL,

PRE, STE); Keeromsberg, Worcester Division (-DA), 4 000-5 000 ft., 7/11/1943, *Esterhuysen* 9231 (BOL, K, NBG, SAM), 5/9/1965, *Taylor* 6445 (K, PRE, STE); Kavadows Mountains, near Orchard, 4 000 ft., 23/11/1944, *Esterhuysen* 10873 (BOL); Blaauwkoop near Keeromsberg, 4 000-4 500 ft., 16/12/1951, *Esterhuysen* 19636 (BOL); Ben Heatlie, summit, 6 600 ft., 8/11/1943, *Esterhuysen* 9202 (BOL); Sawedge Peak, Worcester/ Montagu Division, 5 000 ft., 17/4/1954, *Esterhuysen* 22847 (BOL), 5 000 ft., 22/10/1976, *Rourke* 1597 (NBG),  $\pm$  4 000 ft., 6/9/1965, *Esterhuysen* 31148 (BOL); Rabiesberg Kloof, Worcester Division, -/9/1935, *Walgate s.n.* (BOL); Dry elevated places, Wilde River (near Rabiesberg), *Niven B* (BM); Middelberg between Koo and Matroosfontein, Montagu Division (-DB), 4 000 ft., 24/8/1977, *Williams* 2343 (NBG).

—3320 (Montagu): on road to Pypsteelfontein, Waboomsberg, Montagu Division (-CA), 4 200 ft., 28/5/1975, *Williams* 2005 (NBG); Waboomsberg, west of Pypsteelfontein, c. 4 300 ft., 10/6/1971, *Kruger* 1333 (STE); Highlands, 3.5 miles west of Ouberg Pass Summit, Montagu Division, 3 800 ft., 23/8/1977, *Williams* 2340 (NBG).

Without precise locality: Elevated stony places, Breede River, *Niven A* (BM).

#### DISTRIBUTION AND VARIATION

*Acmadenia matroosbergensis* is found growing only at very high altitudes in dry rocky places on the mountains of the Montagu, Worcester and Ceres Divisions.

A certain amount of variation has been observed in the size of the leaves. Plant populations with large leaves are found on the Schurweberg in the Cold Bokkeveld and populations of plants with very small leaves occur at the opposite end of the distribution range on the Waboomsberg in the Montagu Division. Those populations with roughly intermediate leaves being found in between.

Of those species of *Acmadenia* with the flower standing open, *A. matroosbergensis* is recognised as distinct, having pink flowers with glabrous obovate petals narrowing evenly to the base, with staminodes 0.5 mm long, acute, with an acute gland on the anther, with pointed buds, having leaves oblong-linear, acute, glabrous, and having fruits without horns. It is nearest to *A. argillophila* which however has petals with a short claw and globose buds. It differs from *A. teretifolia* with terete leaves; from *A. tetracarpellata* with a 4-carpellate ovary; from *A. patentifolia* with horned fruits.

**9. *Acmadenia argillophila*** Williams in Jl S. Bot. **45**(2): 160 (1979). Type: CAPE—3320 (Montagu): Boesmansgat Quarry, 9 km east of Jan de Boers, Worcester/Laingsburg Division (-AC), 1 006 m (3 300 ft.), 3/8/1977. *Williams* 2318 (NBG, holotype; BOL, K, MO, PRE, isotypes).

*Acmadenia argillophila* with its branches forked at 90°, small thick sessile leaves, lilac flowers 10 mm diam., orbicular petals short-clawed and spreading and with its 5-carpellate globose hornless fruit, is a distinct species. It differs from *A. teretifolia* with terete leaves; from *A. tetracarpellata* with a

4-carpellate ovary; from *A. patentifolia* with white flowers and horned fruits; from *A. fruticosa* with petiolate leaves and petals bulged inwards at the throat. It is closest to *A. matroosbergensis* which has branchlets densely puberulous; leaves which may be much larger, erect and sparsely ciliate; buds more acute; petals narrowing evenly to the base with many more gland dots; disc exceeding the ovary, closing slightly over it; and staminodes 0,5 mm long, reddened with a minute pointed gland at the apex.

**10. *Acmadenia patentifolia*** Williams in JI S. Afr. Bot. **44**(4): 343 (1978). Type: CAPE—3219 (Wupperthal): on track from Krom River to Breekkrantz, South Cedarberg, Clanwilliam Division (-CB), 914 m (3 000 ft.), 18/9/1975, Williams 2087 (NBG, holotype; K, MO, M, PRE, STE, isotypes).

*Acmadenia patentifolia* is recognised as distinct on account of having very small, thick alternate leaves, small open flowers and a large fruit with long horns. It looks rather like *A. tetracarpellata* which however has somewhat thinner, opposite leaves and a 4-carpellate fruit.

**11. *Acmadenia tetracarpellata*** Williams in JI S. Afr. Bot. **41**(4): 247 (1975). Type: CAPE—3219 (Wupperthal): in sandy soil below small cliffs, Groenfontein, Swarttruggens, Ceres Division (-DC), 1 220 m (4 000 ft.), 20/11/1974, Williams 1928 (NBG, holotype; BOL, K, M, MO, PRE, S, STE, isotypes).

*Acmadenia tetracarpellata* is recognised as distinct on account of its having extremely small open flowers and being the only plant in the genus with a 4-carpellate ovary except for *A. nivea* which however is a much smaller slender plant with small flowers with the petals bulged inwards at the throat and a 3 or 4-carpellate ovary.

**4. *ACMADENIA* sectio *GLANDULA*** Williams, sect. nova. propria propter florem petalis ad fauce approximatis gynoecio plus minusue occulto et antherum glandula apicala coronata.

Section *Glandula* is distinguished by having the flower with petals close together at the throat, more or less concealing the gynoecium and with the anther bearing a small apical gland.

Contains species:

12. *A. fruticosa*
13. *A. burchellii*
14. *A. trigona*
15. *A. latifolia*
16. *A. laxa*
17. *A. alternifolia*
18. *A. kiwanensis*

- 19. *A. densifolia*
- 20. *A. mundiana*
- 21. *A. obtusata*
- 22. *A. maculata*

**12. *Acmadenia fruticosa*** Williams in Jl S. Afr. Bot. **41**(4): 243 (1975). Type: CAPE—3321 (Ladismith): on the south side of road at the summit of Bosluiskloof Pass, Laingsburg Division (-AD), 1140 m (3 750 ft.), 12/7/1974, Williams 1908 (NBG, holotype; C, GRA, K, M, MO, PRE, S, STE, iso-types).

*Acmadenia fruticosa* is recognised as distinct because of having small elliptic leaves and smallish pale pink flowers 10 mm diam. Several other species of *Acmadenia*, namely *A. laxa*, *A. macropetala*, *A. nivenii*, *A. obtusata*, *A. sheilae* and *A. tetragona* have a similar arrangement of opposite leaves and obvallate bracts at the base of the fruit. By the shape of their leaves they are all however easily seen as distinct from *A. fruticosa*.

**13. *Acmadenia burchellii*** Dümmer in Fedde Repert. **11**: 164 (1912). Type: CAPE—3321 (Ladismith): In the ascent up and near the summit of

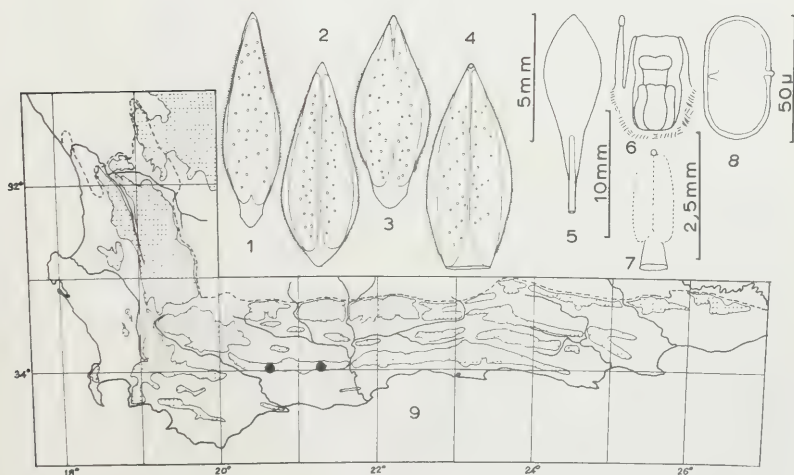


FIG. 12.

*Acmadenia burchellii*: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, gynoecium. 7, probable shape of anther before anthesis. 8, pollen. 9, distribution.



the great mountain at Mountain Station at Valley River Port, Riversdale Division (-CD), 9/12/1814, Burchell 7096 (K, lectotype).

*Shrubs* about 0,3 m tall. *Branches* slender, fairly straight; bark dark brown, somewhat roughened with sloping leaf scars. *Branchlets* fairly numerous, erect, slender, straight, glabrous, leafy, angular when dried with a sharp ridge decurrent from each leaf base. *Leaves* 6–8 mm long, on younger plants up to 10 mm long, 1,4–1,6 mm broad on one side, complicate when dry, lanceolate, acute, glabrous, sub-sessile, erect, imbricate, opposite, apex with a small mucro hooked inwards; margins ciliate, broadly translucent; adaxial surface pubescent towards the apex; abaxial surface glabrous, gland dots scattered. *Bracts* two, opposite, 8 mm long, 3 mm broad, lanceolate-elliptic, acute, sessile; apex with a small callus, sacculate, adaxially pubescent; margins ciliate, broadly translucent; abaxial surface glabrous, sharply ridged, minutely gland-dotted, rather more remote from the bracteoles than usual. *Bracteoles* two, 7 mm long, 3 mm broad, elliptic-lanceolate, acute, sessile; apex with a small callus, sacculate, pubescent inside; margins ciliate, broadly translucent; abaxial surface glabrous, sharply ridged, minutely gland-dotted. *Calyx lobes* five, 8 mm long, 2,6–3,2 mm broad, elliptic-lanceolate, acute; apex with a small callus, somewhat sacculate, pubescent inside; margins ciliate, broadly translucent; abaxial surface glabrous with many small gland dots. *Petals* five, 14–15,5 mm long overall, glabrous; *limb* 8,5 mm long, 4–4,5 mm broad, elliptic, acute with small scattered gland dots, brilliant pink, spreading; *claw* 7 mm long, 1,5 mm broad above, 0,7 mm broad below, midrib prominent. *Staminodes* five, 1,3 mm long, 0,33 mm broad below, tapering, apex glandular, glabrous, purplish. *Filaments* five, becoming 1,8 mm long, acicular, glabrous, purplish. *Anthers* 1,8 mm long, 0,8 mm broad; apical gland minute, sessile, globose. *Pollen* 49  $\mu$  long, 26  $\mu$  broad, oblong. *Disc* obvallate, narrow, exceeds the ovary and stigma by a long way at first. *Stigma* 0,6 mm diam., capitate, depressed globose. *Style* becoming 1,7 mm long, glabrous, rather stout. *Ovary* 5-carpellate, 0,9 mm long, 0,8 mm diam., glabrous; apices globose, somewhat retuse. *Fruit* 5-carpellate, 7 mm long, 5,5 mm diam., glabrous, very few gland dots, remaining more or less hidden within the persistent calyx lobes; horns reduced to a mere point, erect, less than 1 mm long. *Seed* about 4 mm long, black, shining; aril small, white.

Burchell's collections were only acquired by Kew in 1865 and so did not receive the attention of Sonder when he revised the *Diosmeae* for the *Flora Capensis* in 1860. It remained for Dümmer to describe this plant almost one hundred years after its discovery. The above description amplifying that given by Dümmer is based on *Rourke 301* from the north side of the Kamp-scheberg, near the beacon, growing among large sandstone rocks, petals a brilliant pink, only a few plants seen.

## SPECIMENS EXAMINED

CAPE—3320 (Montagu): in saxosis, Langebergen pr. Zuurbraak, Swellendam Division (-DC), 2 000 ft., 23/1/1893, *Schlechter 2155* (BOL).

—3321 (Ladismith): in the ascent up and near the summit of the great mountain at Mountain Station at Valley River Poort, Riversdale Division (-CD), 9/12/1814, *Burchell 7096* (K); summit of Kampscheberg, north side near the beacon, 4 500 ft., 24/1/1966, *Rourke 301* (NBG); Kampscheberg, 3-4 000 ft., -/10/1926, *Thorne s.n.* (SAM 38972); summit of Langebergen at Riversdale, 4 000 ft., 19/5/1950, *Esterhuysen 17024* (BOL, K).

*Acmadenia burchellii* is recognised as distinct having staminodes 1.3 mm long, anthers with a minute sessile apical gland, having bracts, calyx and petals relatively very large with petals glabrous and the disc narrow, exceeding the ovary by a long way. Of those plants with leaves opposite and lanceolate *A. burchellii* differs as follows: *A. densifolia*, *A. baileyensis* and *A. obtusata* have some pubescence on their petals; *A. rupicola* has the anther with a large apical gland; *A. flaccida* has flowers in pairs and *A. trigona* has very much smaller bracts and larger leaves.

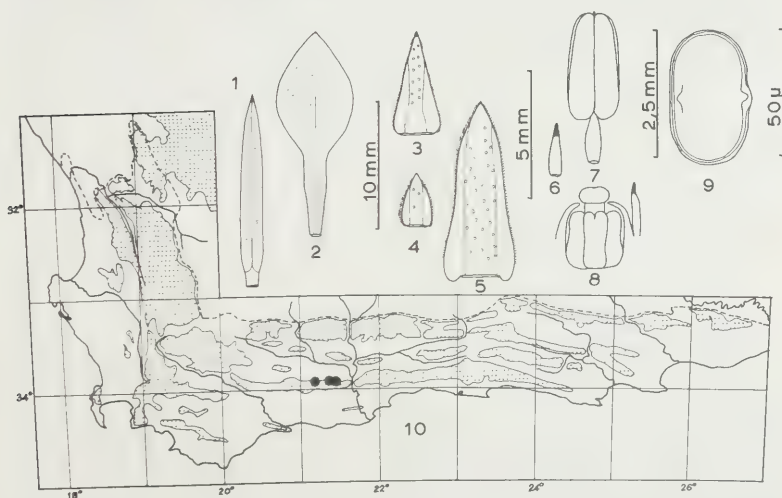


FIG. 13.

*Acmadenia trigona*: 1, leaf. 2, petal. 3, bracteole. 4, bract. 5, calyx lobe. 6, staminate node. 7, anther. 8, gynoecium. 9, pollen. 10, distribution.

**14. *Acmadenia trigona*** (Eckl. & Zeyh.) Druce in Rep. botl Soc. Eych. Club Br. Isl. 1916: 602 (1917). Type: In lateralibus montium (altit III) non procul a flumine Gauritzrivier prope villam Gideon Joubert terrae Cana-

land (Swellendam); Oct. Nov. Ecklon & Zeyher 792 (S, lectotype; MEL, SAM, isotypes).

*Adenandra trigona* Eckl. & Zeyh., Enum. Plant.: 100 (1835). Type: as above.

*Acmadenia psilopetala* Sonder in Fl. Cap. 1: 380 (1860). Type: as above.

*Shrubs* 0,3–0,4 m tall, weak, semi-decumbent, single-stemmed at base. *Branches* few, slender, short, glabrous, smooth, bark brown, leaf scars not prominent. *Branchlets* slender, short, minutely puberulous, reddened, not much hidden by the leaves. *Leaves* 10–17 mm long, 1,5–2 mm broad, linear-lanceolate, acute, mucronate, glabrous, opposite, decussate, sub-imbricate or distant, erect or spreading, somewhat complicate when dry; margins narrowly cartilaginous, somewhat scabrid, villous-ciliate becoming eciliate; adaxial surface from convex to deeply canaliculate; abaxial surface rounded, midrib prominent, gland-dotted to either side; narrowed below to a short petiole. *Inflorescence* solitary, terminal and in the axils of the uppermost leaves, 20–27 mm diam., pink. *Bracts* on axial flowers, two, above two rudimentary leaves, 2 mm long, 1,2 mm broad, ovate or lanceolate, acute, ciliolate, sparsely pubescent adaxially, otherwise glabrous; margins broadly translucent, 1 or 2 gland dots near the midrib. Bracts on terminal flowers exactly like a pair of leaves 15 mm long with convex adaxial surface, villous ciliate. *Bracteoles* two, 3,5–5,9 mm long, 1,6–1,8 mm broad, lanceolate, acute with a red tip, glabrous, ciliolate or ciliate, margins translucent, 2 rows of gland dots along the midrib. *Calyx lobes* five, 6–7,5 mm long, 2,3–2,7 mm broad, lanceolate, acute, ciliate, adaxially thinly pubescent above, otherwise glabrous; abaxial surface rounded, multi-gland-dotted, shining, coloured; margins broadly translucent below. *Petals* five, 16 mm long overall; *limb* 10 mm long, 6 mm broad, elliptic, acute, apiculate, glabrous multi-gland-dotted on the underside, pink, spreading; *claw* 6 mm long, 1,8 mm broad, narrowing to the base, glabrous, bulged inwards at the throat closing the tube. *Staminodes* five, 1 mm long, glabrous, apex glandular acute. *Filaments* five, becoming 1,7 mm long, acicular, glabrous, incurved. *Anthers* five, 2,1 mm long, 1 mm broad, yellow; apical gland minute, pointed, about twice the size of a grain of pollen. *Pollen* 53  $\mu$  long, 31  $\mu$  diam., elliptic, turgid when fresh or 58  $\mu$  long, 25  $\mu$  diam., oblong, shrunken, possibly having been sucked out by a species of thrips. *Disc* dome-shaped, closes over the ovary to meet the stigma, not shining, pale green, exudes nectar at base of filament. *Stigma* 0,6 mm diam., capitate, pale green. *Style* becoming 1,5 mm long, glabrous, erect. *Ovary* 5-carpellate, 1,1–1,3 mm long, 1–1,1 mm diam., glabrous, apices emarginate. *Fruit* 5-carpellate, 7 mm long, 4,5 mm diam., entirely surrounded by the persistent calyx lobes, glabrous, gland-dotted mainly towards the margins; *horns*  $\pm$  1 mm long, erect, emarginate. *Seed* 5 mm long including the white aril, 1,8 mm broad, black, shining.

Ecklon and Zeyher, as was usual, no doubt distributed duplicates of this species to many herbaria. It follows that there are probably several isotypes preserved in other herbaria under *Adenandra trigona* which, having not been seen by the present writer, are not here cited. The above description, done from fresh material, amplifies those previously given.

#### SPECIMENS EXAMINED

CAPE—3321 (Ladismith): top of Garcias Pass, Riversdale Division (-CC), 14/9/1937, *Salter* 6907 (BM, K); Garcias Pass near Toll House, 1 000 ft., 7/10/1897, *Galpin* 3845 (BOL, GRA, PRE); inter restiones in declivibus saxosis, Garcias Pass, 1 400 ft., -/10/1904, *H. Bolus* 11236 (BOL, K); lower north slopes of Langebergen above Garcias Pass, 15/5/1950, *Esterhuysen* 16990 (BOL, K, LD, NBG), -/11/1913, *Muir* 1254 (BOL), 4/8/1976, *Goldblatt* 3765 (MO); Garcia Forest Station, slopes in kloof, 25/5/1950, *Esterhuysen* 17248 (BOL, NBG), -/11/1949, *Stokoe* s.n. (SAM 64180); Garcias Pass, 1 400 ft., -/10/1923, *Muir* s.n. (GRA), -/9/1908, *Phillips* 327 (K, SAM, STE.), 1 200 ft., 5/4/1926, *Smith* 2760 (K, PRE), *L. Bolus* s.n. (K), 5/8/1951, *Barker* 7367 (NBG), 6/4/1959, *Barker* 8950 (NBG), 1 800 ft., 23/9/1949, *Acocks* 15426 (PRE), 1 000–2 000 ft., -/10/1926, *Thorne* s.n. (SAM 38851); Ad lat. mont. pone Gauritz River, Swellendam, (-CD), -/10/-, *Zeyher* s.n. (SAM 14250); in lateralibus montium (altit. III) non procul a flumine Gauritzrivier prope villam Gideon Joubert terrae Cannaland (Swellendam), Oct. Nov., *Ecklon & Zeyher* 792 (S, MEL); at Groot Waterfal, north slopes of Langeberg, between Muiskraal and Cloetes Pass, 1 450 ft., 5/5/1972, *Rourke* 1340 (NBG); Rietvlei, north side of Langeberg, 1 300 ft., 3/11/1975, *Williams* 2140 (NBG).

#### DISTRIBUTION AND VARIATION

*Acmadenia trigona* is found on north-facing dry rocky slopes of the Langeberg from Garcias Pass to near Rietvlei which lies about 25 km to the east of Garcias Pass. No appreciable variation has been noticed.

Of those species of *Acmadenia* in which the throat is closed, *A. trigona* is recognised as distinct having the staminodes 1 mm long with a pointed gland at the apex and the apical gland on the anther absolutely minute and acute, also having leaves opposite, linear-lanceolate, acute, villous-ciliate, glabrous, having petals glabrous at the throat, the disc closing over the ovary and the seed with a white aril. It differs from *A. gracilis* which has smaller leaves, a relatively large pointed gland on the anther and petals pubescent at the throat; from *A. latifolia* which has much broader leaves and petals with the claw sparsely ciliate; from *A. obtusata* which has smaller staminodes and a larger gland 0.4 mm long on the anther, leaves with margins scabrid-serrulate not villous-ciliate and petals with very few gland dots; from *A. densifolia* which has leaves crisped pubescent.

**15. *Acmadenia latifolia*** Williams, sp. nov. affinis *A. trigona* (Eckl. & Zeyh.) Druce sed foliis latoribus et unguis sparsim ciliolatis differt.

*Frutex* 0.3–0.6 mm, semi decumbens, ad basim monocaulis. *Rami* flex-

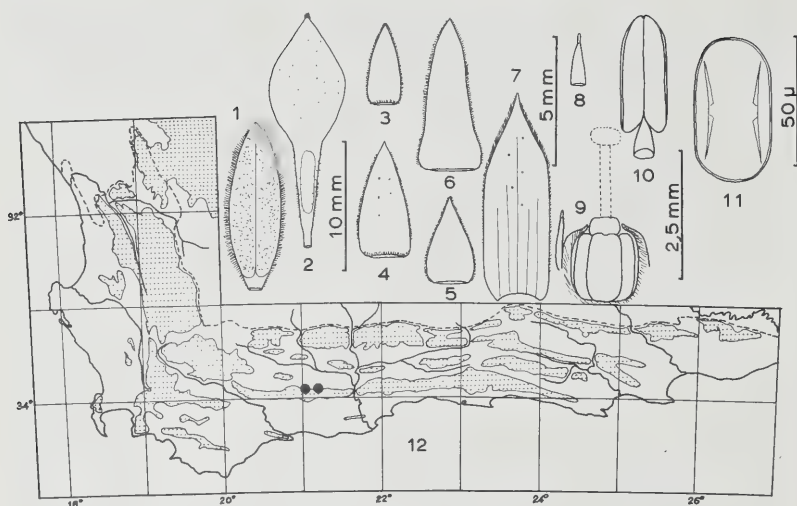


FIG. 14.

*Acmadenia latifolia*: 1, leaf flattened out. 2, petal. 3, first pair of bracts. 4, abaxial bract. 5, adaxial bract. 6, bracteole. 7, calyx lobe. 8, staminode. 9, gynoecium with disc and staminode. 10, anther. 11, pollen. 12, distribution.

uosi, laxiusculi, glabrescenti. *Ramuli* brevi, erectiusculi, pauci, pubescenti, foliosi. *Folia* 12,5–13,5 mm longa, 4 mm lata ubi expansa, lanceolato-elliptica, sub-acuta, mucronata, complicata, sessilia, opposita, decussata, sub-imbricato-erecta, margine villosa-ciliata anguste hyalina, pagina adaxialis profunde canaliculata glabra, pagina abaxialis multi-glanduloso-punctata forte costata. *Inflorescentia* terminalis vel axillaris, solitaria, sessilia. *Flos* 21 mm diam., rosea. *Bracteae* variantes. *Bracteolae* duae, 5,9 mm longae, 2,5 mm ad basim latae, sub-acutae, crispo-ciliatae, glabrae, glanduloso-punctatae. *Sepala* quinque, 8 mm longa, 2,5 mm lata, lineare-lanceolata, acuta, apex recurva, margine ciliata, pagina adaxialis minute puberula, pagina abaxialis glabra, glanduloso-punctata. *Petala* quinque, 18–19 mm longa in toto; *limbus* 10 mm longus, 6–6,8 mm latus, late lanceolatus, acutus, roseus, patens, glaber, glanduloso-punctatus; *unguis* 8 mm longus, 2 mm latus ad basim decrescens, glaber, glanduloso-punctatus, in medio minute ciliolatus. *Staminodia* quinque, 1,5 mm longa, glaber, glanduloso-coronata. *Fila* quinque, 1,5 mm longa, subulata, glabra. *Anthera* quinque, ante anthesin 2,3 mm longae, 0,9 mm latae, auriantiacae, glandula 0,1–0,15 mm longa coronata. *Pollen* 56  $\mu$  longum, 30  $\mu$  latum, oblongum. *Discus* viridus, ovarium inclusum, nectarifer. *Stigma* 0,6 mm diam., depresso-globosum. *Stylus*



fere 2 mm longus, glaber, erectus. *Ovarium* 5-carpellatum, 1,3 mm longum, 1,2 diam., glabrum, apicibus emarginatis. *Fructus* 5-carpellatus, 7 mm longus, 5,6 mm diam., glaber. *Cornua* 1,5 mm longa, erecta, emarginata, minute et sparsim setulosa. *Semen* 4,5 mm longum, 1,8 mm latum, piceum, nitens; arilus ex parte brunneolus.

*Type*: CAPE—3321 (Ladismith): Kanetberg, Gysmanshoek Pass, North side, Heidelberg Division (-CC), 760 mm (2 500 ft.), 17/10/1978, *Williams* 2615 (NBG, holotype; BOL, PRE, MO, isotypes).

*Shrubs* 0,3–0,6 m tall, with few branches rising from a single stem at base. *Branches* short, rather lax, variously bent, glabrescent; bark dark brown, rough with leaf scars. *Branchlets* short, fairly erect, few, densely pubescent, reddish, well clothed with leaves. *Leaves* 12,5–13,5 mm long, 4 mm broad if pressed flat, lanceolate-elliptic, sub-acute, mucronate, complicate, sessile, opposite, decussate, sub-imbricate, erect; margins villous-ciliate mainly below, narrowly cartilaginous; adaxial surface glabrous, deeply grooved; abaxial surface prominently ribbed with gland dots scattered to either side. *Inflorescence* at first terminal then, on the same twig, crowded in three opposite pairs in the uppermost axils of the leaves; *flowers* 21 mm diam., solitary, sessile, pink. *Bracts* 2 pairs, varying in size depending on whether the flower is terminal or axial, 3,1–13 mm long, 1,3–2,5 mm broad, lanceolate, acute, ciliate; adaxially pubescent except for the posterior bract; abaxially glabrous to thinly puberulous; anterior bract gland-dotted and green towards the midrib above. *Bracteoles* two, 5,9–8,5 mm long, 2,5–2,8 mm broad, narrowing to the apex, acute, crisped ciliate mainly above, glabrous; midrib prominent, multicoloured, gland-dotted above; margins translucent below. *Calyx lobes* five, 8–9,5 mm long, 2,5–3 mm broad, lanceolate, acute, apex recurved, margins ciliate, densely so above; adaxial surface minutely puberulous mainly above; abaxial surface glabrous, gland-dotted and purplish above. *Petals* five, 18–19 mm long overall, soon falling; *limb* 10 mm long, 6–6,8 mm broad, broadly lanceolate, acute, glabrous, pink, spreading, abaxially gland-dotted, apex with a few hairs; *claw* bulged inwards at the throat, 7,5–8 mm long, 2–2,3 mm broad above narrowing below, glabrous, gland-dotted to either side, very sparsely ciliate. *Staminalodes* five, 1 mm long, 0,3 mm broad, pale, glabrous, tapering to a small pointed gland at the apex. *Filaments* five, becoming 1,5–2,3 mm long, subulate, glabrous. *Anthers* five, before anthesis 2,3 mm long, 0,9 mm broad, yellow with a minute (0,1–0,15 mm long) pointed apical gland inclined inwards. *Pollen* 56  $\mu$  long, 30  $\mu$  broad, oblong. *Disc* closes over the ovary at first touching the stigma, green, exudes nectar. *Stigma* 0,6 mm diam., depressed, globose, 5-lobed. *Style* becoming nearly 2 mm long, glabrous erect, persisting. *Ovary* 5-carpellate, 1,3 mm long, 1,2 mm diam., glabrous, apices

emarginate. *Fruit* 5-carpellate, 6,8–7 mm long, 5–5,7 mm diam., pale, glabrous below, margins gland-dotted, sparsely pubescent, closely surrounded by the persistent calyx lobes; *horns* 1,5 mm long, sparsely and minutely setulose, emarginate. *Seed* 4,5 mm long, 1,8 mm broad, black, shining; aril pale, partly light brown.

It would appear that this plant was first collected by E. E. Galpin in 1897 at Muiskraal near Garcias Pass on the north side of the Langeberg. Type material used in this description was collected at Gysmanshoek Pass which lies to the west of Muiskraal and is also on the north slopes of the Langeberg.



FIG. 15.  
*Acmadenia latifolia*: flower showing the closed throat.

#### SPECIMENS EXAMINED

CAPE—3321 (Ladismith): Muiskraal near Garcias Pass, south side of ridge, Riversdale Division (-CC), 1 200 ft., 3/10/1897, *Galpin* 3847 (BOL, GRA, PRE), 13/6/1961, *van Breda* 1089 (PRE), 4/8/1976, *Goldblatt* 3761 (MO); in planite summam partem viae inter Garcias Pass et Muiskraal, 1 800 ft., -/10/1904, *H. Bolus* 11237 (BOL, GRA); north end of Garcias Pass, 2 000 ft., 23/9/1949, *Acocks* 15431 (G, K, PRE); hills north of Garcias Pass, 2 000 ft., 3/11/1975, *Williams* 2139 (NBG); Garcias Pass, -/10/1926, *Thorne* s.n. (SAM 38851), 9/8/1949, *Barker* 5520 (NBG), -/9/1908, *Phillips* 372 (SAM); Kanetberg, Gysmanshoek Pass north side, Heidelberg Division, 2 500 ft., 17/10/1978, *Williams* 2615 (NBG, BOL, PRE, MO); north side of Gysmanshoek Pass, 2 400 ft., 4/12/1978, *Williams* 2656 (NBG, BOL, PRE, STE).

## DISTRIBUTION

This species is very local. It is known only from two localities, one at Gysmanshoek Pass and the other at Muiskraal. They are 13 km apart.

Of those species of *Acmadenia* with opposite leaves and with the throat of the flower closed by the petals, *Acmadenia latifolia* is recognised as distinct having staminodes 1 mm long with a pointed gland at the apex and the apical gland on the anther absolutely minute, also having leaves lanceolate-elliptic, villous ciliate, glabrous, having petals glabrous at the throat with the claw sparsely ciliate, the disc closing over the ovary and the seed with the aril brownish on one side. It is most like *A. trigona* which however has petals with the claw eciliate and narrower leaves.

**16. *Acmadenia laxa*** Williams in Jl S. Afr. Bot. **40**(4): 283 (1974). Type: CAPE—3420 (Bredasdorp); Bontebok National Park, Swellendam (-AB), 110 m, 27/7/1973, Williams 1828 (NBG, holotype; M, MO, PRE, S, STE, isotypes).

*Acmadenia obtusata* sensu Bartl. & Wendl. Diosm. in Beitr. Bot. **1**: 63 (1824).

*Acmadenia muraltioides* Eckl. var. *minor* Presl. nom. nud.

*Acmadenia laxa* is recognised as distinct on account of its having leaves that are opposite and obtuse, flowers solitary, with numerous pairs of bract-like leaves at the base of each, and anthers bearing a minute apical gland. It differs from *A. nivenii*, *A. macropetala* and *A. sheilae* which have the anther with a large pointed apical gland, and from *A. gracilis*, *A. obtusata* and *A. trigona* which have leaves acute.

**17. *Acmadenia alternifolia*** Chamisso in Linnaea **5**: 52 (1830). Type: C.B.S. ad Hangklipp, -/7/1821, Mundi et Maire s.n. (K, lectotype; E, P, G, S, isotypes).

*Shrubs* up to 1 m tall, single-stemmed at base, lower branches variously bent, bark very rough. One stem about 25 mm diam., showed about 50 annual growth rings. *Branches* short, slender, lax, puberulous, rough with leaf scars, dusky brown. *Branchlets* short, slender, clustered, somewhat erect, densely leafy, puberulous. *Leaves* 6.5–12 mm long overall, 1.3–2 mm broad, linear or linear-lanceolate, acute with a sharp mucro, crowded, alternate, fairly erect, incurved towards the apex; margins thinly cartilaginous, minutely scabrid; petiole 1.5–2 mm long, 0.7 mm broad, minutely pubescent; adaxial surface flat, concave when dry, dark green, scabrid; abaxial surface with the midrib prominent and scabrid, with a single row of gland dots to either side and a few along the margins. *Inflorescence* terminally sessile, crowded, each flower on a very short branchlet. *Bract* 5 mm long in-

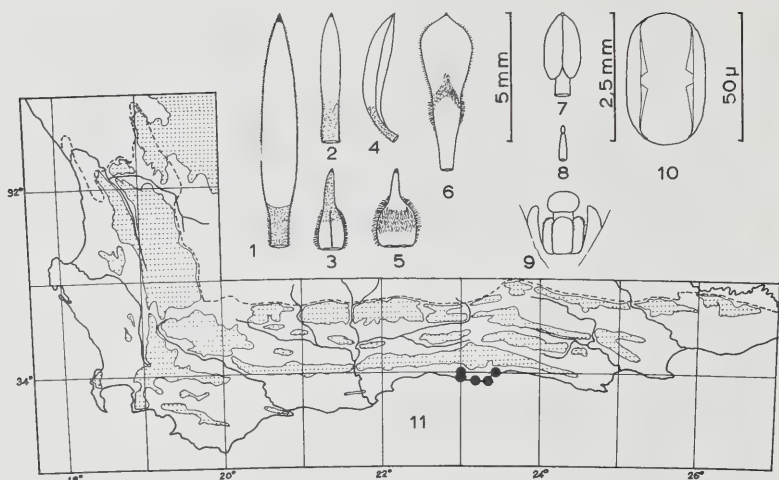


FIG. 16.

*Acmadenia alternifolia*: 1, leaf. 2, bract. 3, bracteole. 4, side view of bract. 5, calyx lobe viewed from inside. 6, petal. 7, anther. 8, staminode. 9, gynoecium. 10, pollen. 11, distribution.

cluding the pubescent petiole, 1,5 mm long, 0,8 mm broad, tumid, incurved, linear, acute, minutely mucronate, scabrid. *Bracteoles* up to five, the innermost about 3 mm long, 1 mm broad, translucent and ciliate below, narrowing above to a tumid scabrid awl-shaped point, adaxially pubescent towards the base. *Calyx lobes* five, 3 mm long, 1,5 mm broad translucent and crisped ciliate below, apiculate and scabrid above; apex mucronate, spreading, adaxially adpressed pubescent about the middle. *Petals* five, 6 mm long overall; *limb* 2–2,7 mm broad, apiculate, sparsely ciliolate, without gland dots, spreading; *claw* about 3 mm long, 1,1 mm broad, ciliate, somewhat pubescent and projecting inwards at the throat. *Staminodes* five, 0,7 mm long, glandular at the apex, glabrous. *Filaments* five, becoming 2,3 mm long, acicular, glabrous. *Anthers* five, before anthesis 1,3 mm long, 0,7 mm broad, yellow, apical gland minute. *Pollen* 51  $\mu$  long, 31  $\mu$  diam., ellipsoid. *Disc* exceeds the ovary, obvallate, green, exudes nectar. *Stigma* 0,5 mm diam., capitate, globose. *Style* 1 mm long, terete, glabrous, erect. *Ovary* 5-carpellate, 0,8 mm diam., glabrous, green. *Fruit* 5-carpellate, 12 mm long, sparsely puberulous with a few gland dots at the sides otherwise glabrous; *horns* 4 mm long, slightly incurved, with an immersed gland at the apex. *Seed* 5 mm long, 2,2 mm broad, black, shining; aril small, black on one side.

It has not been found possible to trace the locality "Hangklipp" given by

Munt & Maire. As this plant has been found in exposed positions on dry cliffs near the coast from Knysna to Plettenberg Bay, this name must refer to a prominence somewhere in this area. In *Linnaea* under *Rutaceae* it states quite plainly that Adelberto de Chamisso is the sole author. The name of von Schlechtendal should therefore not be attached to this species. The above description done from fresh material may possibly amplify that previously given by Chamisso.

#### SPECIMENS EXAMINED

CAPE—3323 (Willowmore): Klein Gouna Plateau, steep dry slopes of Knysna River, Knysna Division (-CC), 500 ft., -/7/1921, *Keet s.n.* (STE 13757); Keurbooms River, low stony hills near river mouth (-CD), 8/11/1928, *Gillett 2215* (BOL); Knysna, Matjiesfontein (old road at Keurbooms River), 500 ft., -/11/1928, *Fourcade 4168* (BOL-FOURC).

—3422 (Mossel Bay): Phantom Pass on steep rocky north slope (-BB ?), -/9/1922, *Keet 1036* (GRA).

—3423 (Knysna): At Zandkraal on the western side of the Knysna drift, near the foot road (-AA ?), 13/7/1814, *Burchell 5532* (BOL, G, K, MEL, P, S, W); Harkerville Forest Reserve, above Stevens Bank, 520 ft., 5/7/1973, *Williams 1820* (NBG); C.B.S. found near Plettenberg Bay (-AB), *Bowie s.n.* (BM); Plettenberg Bay Reserve, hill slopes above coast, 11/5/1961, *Lewis 5768* (NBG); Vyekraal, Plettenberg Bay, Knysna Division, 200 ft., 5/7/1973, *Williams 1819* (NBG).

#### DISTRIBUTION

*Acmadenia alternifolia* appears to be fairly local, so far having been found only in an area near to and along the coast from the Knysna River to the Keurbooms River. No variation has been noticed.

*Acmadenia alternifolia* is recognised as distinct having staminodes 0.7 mm long and anthers with a minute apical gland, having leaves linear-lanceolate, incurved acute, keeled with two rows of gland dots, margins minutely scabrid and having fruits with horns about 4 mm long. Only three other species of *Acmadenia* have fruits with long horns and from these *A. alternifolia* differs as follows: *A. flaccida* has opposite leaves; *A. patentifolia* has very small thick sessile leaves; *A. tenax* has the style deflexed at some stage.

**18. *Acmadenia kiwanensis*** Williams in Jl S. Afr. Bot. **44**(4): 347 (1978). Type: CAPE—3327 (Peddie): on right hand side of road to Kiwane, 2.6 km from main Peddie/East London road (-BA), 122 m (400 ft.), 9/3/1976. *Williams 2175* (NBG, holotype; BOL, GRA, K, MO, NSW, PRE. S. iso types).

*Acmadenia kiwanensis* is recognised as distinct on account of having leaves alternate, lanceolate, acute, puberulous with the tips pale and minutely bristly and in having fruits somewhat pubescent with fairly short



horns and imbricated only towards the base by the calyx lobes. Geographically the nearest species is *A. obtusata* which has leaves nearly always opposite, with bracts and bracteoles apiculate and with fruits glabrous, short horned and more or less hidden by the calyx lobes. Still further away, *A. alternifolia* can be distinguished by its fruits with much longer horns.

**19. *Acmadenia densifolia* Sonder in Fl. Cap. 1: 380 (1860). Type:** CAPE—3421 (Riversdale): Hoëkraal, between Kafferkuils river and Zoetmelks river on limestone hills, Riversdale Division (-AB), 500–1 000 ft., (IV, C, a, 3), 17/8/1831, *Drège* 7145 (S, holotype; P, isotype).

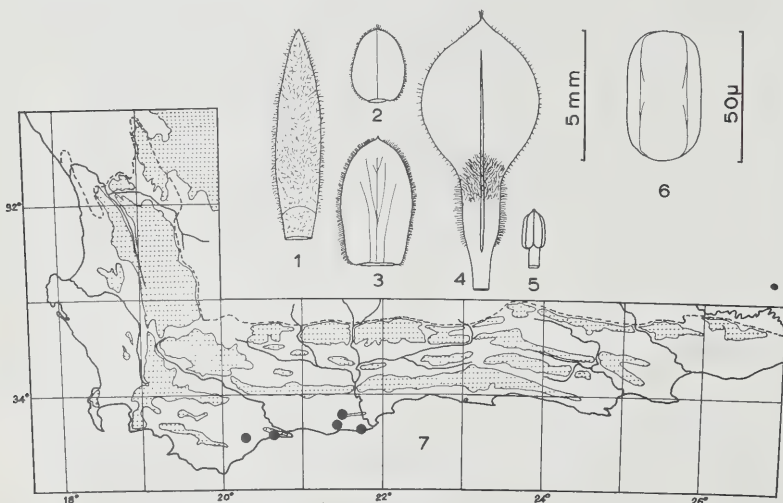


FIG. 17.

*Acmadenia densifolia*: 1, leaf. 2, bracteole. 3, calyx lobe. 4, petal. 5, anther. 6, pollen. 7, distribution.

*Shrubs* up to 0,6 m tall, single-stemmed at base. *Branches* fairly erect, slender, short, glabrescent, the bark fairly smooth. *Branchlets* short, slender, erect, densely crisped pubescent, well clothed with leaves. *Leaves* 7–12 mm long, 1,7–2,3 mm broad, lanceolate, acute, somewhat complicate, usually alternate, imbricate, adpressed erect; apex rubro-mucronate, somewhat incurved; margins narrowly translucent, crisped ciliate; petiole broad, very short; adaxial surface glabrous; abaxial surface crisped pubescent mainly along the prominent midrib, gland-dotted between midrib and margins. *Inflorescence* solitary at the ends of short branchlets or almost axial in groups

at the ends of branchlets, upper or involucre leaves becoming bract-like; flowers 12 mm diam., pink or pale purple in colour. *Bracteoles* two, 2,8 mm long, 2 mm broad, ovate, ciliolate, apex minutely tufted, glabrous, midrib green. *Calyx lobes* five, 5 mm long, 2,7 mm broad, oblong, obtuse, apiculate, ciliate, distinctly veined; adaxial surface sparsely pubescent towards the centre; abaxial surface glabrous, purplish towards the apex. *Petals* five, 10,5 mm long; *limb* 6,5 mm long, 4,5 mm broad, orbicular, apiculate, sparsely ciliate, upper surface sparsely puberulous; *claw* 4 mm long, 1,5 mm broad above narrowing to 0,6 mm below, densely bearded on the "chin" at the throat, ciliate, margins translucent. *Staminodes* five, 0,15 mm long, 0,1 mm diam., ovoid. *Filaments* five, becoming 1,8 mm long, acicular, glabrous. *Anthers* five, before anthesis 1,5 mm long, 0,9 mm broad, yellow, apical gland 0,1 mm long, ovoid. *Pollen* 50  $\mu$  long, 28  $\mu$  broad, oblong. *Stigma* 0,7 mm diam., globose, capitate, dark green. *Style* becoming 1,6 mm long, erect, glabrous. *Ovary* 5-carpellate, 1 mm diam.; carpels very sparsely pubescent at the sides, apices glabrous somewhat emarginate towards the inside. *Fruit* (immature) 5-carpellate, carpels smooth, without gland dots, very sparsely pubescent on the margins above; *horns* emarginate, very short. *Seed* (from Esterhuysen 19528) 3,4 mm long, 1,3 mm broad, black, shining.

The holotype seen by Sonder is preserved in his herbarium at Stockholm. The locality given by Sonder in *Flora Capensis* is in error due to a misprint in Drège's *Documente* page 161 where *Acmadenia* 7145 printed as IV, C, c, 3 should read IV, C, a, 3 as it appears on page 123 earlier in the text. An examination of the label on the specimen in Drège's herbarium preserved at Paris reveals yet another error in that the correct altitude is stated as being 500–1 000 ft., not below 500 ft. as in the text of Drège's *Documente*. Taking these errors into consideration it was comparatively easy to rediscover this plant in its type locality. The above description done from fresh material amplifies that previously given by Sonder.

#### SPECIMENS EXAMINED

CAPE—3420 (Bredasdorp): Vanderstelskraal, summit of limestone hills, Bredasdorp Division (-AC), 450 ft., 2/7/1972, *Williams* 1663 (NBG); 500 ft., 1/8/1968, *Acocks* 24046 (K); Melkkamer farm, upper S. slopes of limestone hills at Wolfkloof 6 km from De Hoop Vlei, 100 m alt., 18/9/1979, *Burgers* 2289 (CPA Nat. Cons. Herb.); Lekkerwater farm, limestone hills between Potberg and the sea, Bredasdorp Division (-BC), 8/9/1973, *Powrie* 263 (BOL); Potberg, Hamerkop, near track turning off to the coast, 170 m alt., 28/5/1980, *Burgers* 2381 (CPA Nat. Cons. Herb.). —3421 (Riversdale): near Askop, S. side of main road 10 miles W. of Albertiniv, Riversdale Division (-AB), 600 ft., 2/3/1974, *Williams* 1880 (NBG); Hoëkraal between Kafferkuils river and Zoetmelks river on limestone hills, 500–1 000 ft., (IV, C, a, 3), 17/8/1831, *Drège* 7145 (P. S); rocky ridges at Droëvlakte, Riversdale Division (-AD), -/9/1913, *Muir* 1091 (BOL); Melkhoutfontein, 600 ft., 7/10/1897, *Galpin* 3846 (BOL, GRA); limestone hills along the road to Still Bay, 7/12/1951, *Esterhuysen*

19528 (BOL, K); Riethuiskraal off Still Bay road, 13/4/1962, *Lewis 5924* (NBG); Still Bay hills, 4/8/1951, *Johnson 111* (NBG); Buffelshoek near sea, in rocky places (-BC/BD), -/9/1913 *Muir 1104* (BOL, K).

#### DISTRIBUTION

*Acmadenia densifolia* is found growing on limestone hills belonging to the tertiary Bredasdorp beds between Bredasdorp and Albertinia.

It is recognised as distinct, having staminodes and the small gland on the anther ovoid and having leaves lanceolate, usually alternate, adpressed erect, the apex rubro-mucronate, incurved, margins crisped ciliate, the abaxial surface crisped pubescent mainly along the prominent midrib. It differs from other species of *Acmadenia* with lanceolate alternate leaves as follows: from *A. rupicola* which has large conical anther glands; from *A. obtusata* which has leaves glabrous; from *A. kiwanensis* and *A. tenax* which have leaf margins not crisped ciliate; from *A. wittebergensis* which has leaves round-backed without prominent midrib; from *A. alternifolia* which has fruits with long horns.

**20. *Acmadenia mundiana*** Ecklon & Zeyher, Enum. Plant.: 105 (1835). Type: In montium lateribus prope Swellendam, -/10/-, *Mundt s.n.* (SAM, lectotype; S, isotype).

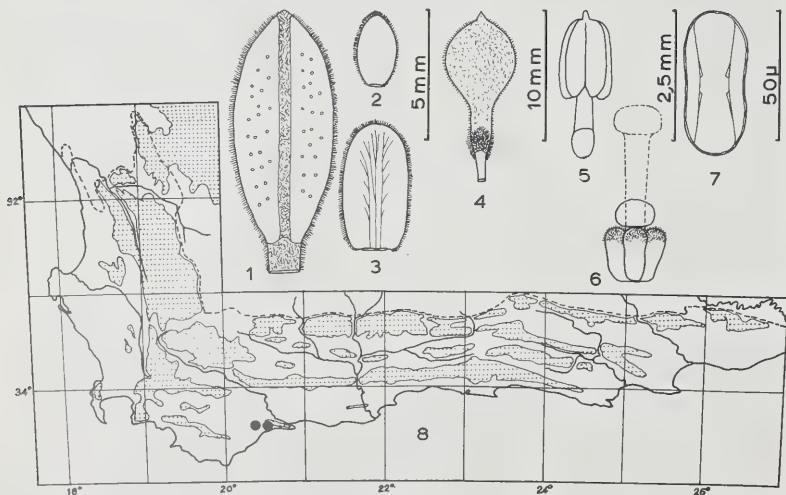


FIG. 18.

*Acmadenia mundiana*: 1, leaf. 2, bracteole. 3, calyx lobe. 4, petal. 5, anther. 6, gynoecium. 7, pollen. 8, distribution.

*Acmadenia cucullata* E. Meyer ex Sonder in Fl. Cap. 1: 381 (1860). Type: Limestone hills between Cape Agulhas and Potberg, below 500 ft., (IV, C, a, 2), 3/8/1831, Drège s.n. (BM, G, K, MEL, P (E. Meyer 3549), PRE, S, W).

*Acmadenia neglecta* Dümmer in Fedde Repert. 11: 120 (1912). Type: Drège s.n. (K).

*Shrubs* up to 1,2 m tall, well-branched, single-stemmed at base. *Branches* short, fairly erect, glabrescent. *Branchlets* short, erect, puberulous, densely leafy. *Leaves* up to 11 mm long, those of younger plants larger and more pubescent, 3,8–4,8 mm broad, elliptic, obtuse, petiolate, alternate; margins narrowly cartilaginous, scabrid, crisped ciliate when young; adaxial surface grooved down the middle, minutely puberulous; abaxial surface scabrid, often minutely puberulous, gland-dotted with the midrib prominent, scabrid, pubescent or shaggy pubescent. *Inflorescence* terminal, solitary, 15 mm diam., pink, closed at the throat. *Involucral leaves* much reduced, becoming bract-like. *Bracteoles* two, 2,7 mm long, 1,5 mm broad, elliptic, obtuse, concave, translucent, glabrous, ciliate; apex soon withering. *Calyx lobes* five, 5–6 mm long, 2,5–3 mm broad, oblong, obtuse, pseudo-apiculate due to the inrolled margins and with a tuft of hairs, 3-veined, glabrous, ciliate, translucent, shining. *Petals* five, vary in size, 13 mm long; *limb* 7 mm long, 5,5 mm broad, orbicular, apiculate, thinly puberulous above, ciliate; *claw* 6 mm long, 1,5 mm broad above, 0,8 mm broad below, ciliate and pubescent above, arched inwards almost closing the throat. *Staminodes* five, 0,2–0,4 mm long, fusiform, glabrous. *Filaments* five, becoming 2,4 mm long, acicular, glabrous. *Anthers* five, before anthesis 1,7–1,8 mm long overall, 1 mm broad, yellow; apical gland 0,2 mm long, sub-acute. *Pollen* 55  $\mu$  long, 24  $\mu$  diam., oblong. *Disc* obvallate, exceeds the ovary, green, quite fleshy, exudes nectar. *Stigma* 1 mm diam., globose, capitate. *Style* becoming 1,5–2,3 mm long, glabrous, erect. *Ovary* 5-carpellate, 1 mm long, 1,2 mm diam.; apices globose, puberulous, adaxially emarginate. *Fruit* 5-carpellate, 5 mm long, 4,5 mm diam., enclosed within the persistent calyx lobes; carpels glabrous, smooth, gland-dotted towards the margins; *horns* very short, 0,3 mm long, emarginate, echinulate. *Seed* 3,5–3,8 mm long, 1,5–1,6 mm broad, black, shining; aril black on one side.

The locality where *Acmadenia mundiana* is found lies 40 km south of Swellendam. But as Swellendam was the only landmark for many miles around, the locality given by Mund "on mountain slopes near Swellendam" is perhaps not too wide of the mark. As the whereabouts of the specimen actually seen by Ecklon & Zeyher is unknown, the fragment preserved in the herbarium of the South African Museum at Kirstenbosch has been chosen as the lectotype.

Specimens resembling *Acmadenia cucullata*, other than those collected

by Drège, had not been seen in any herbarium nor had any been observed in the field until Mr. C. Burgers of the Department of Nature Conservation in 1979 discovered a hybrid swarm, near De Hoop Vlei, of plants grading from *Acmadenia obtusata* (Thunb.) Bartl. & Wendl. to *Acmadenia mundiana* Eckl. & Zeyh. Amongst these were populations of plants resembling Drège's collection of *Acmadenia cucullata*.

The above description done from fresh material amplifies those previously given.

#### SPECIMENS EXAMINED

CAPE—3420 (Bredasdorp): Limestone hills between Cape Agulhas and Potberg (-AD), below 500 ft., (IV, C, a, 2), 3/9/1931, *Drège s.n.* (BM, G, K, MEL, P (*E. Meyer* 3549), PRE, S, W); De Hoop, limestone hills, 8/4/1957, *Barker* 8683 (BOL, NBG), 9/6/1970, *Esterhuysen* 32468 (BOL), 5/2/1963, v. d. *Merwe* 1366 (K, PRE, STE), 100 ft., 28/7/1970, v.d. *Merwe* 125 (K, STE), -/7/1962, *Macpherson s.n.* (NBG), 14/9/1962, *Lewis* 6022 (NBG), 10/9/1969, *Rourke* 1214 (NBG), 150 ft., 15/4/1972, *Williams* 1646 (NBG), 600 ft., 15/4/1972, *Williams* 1647 (NBG), 5/9/1964, *van Breda* 1715 (PRE, STE); north side of pass from Wydgelegen to De Hoop, 600 ft., 22/9/1962, *Acocks* 22762 (K, PRE), 300 ft., 26/8/1963, *van Breda* 1638 (K, PRE), 350 ft., 9/4/1974, *Williams* 1886 (NBG), 600 ft., 9/4/1974, *Williams* 1889 (NBG), 350 ft., 3/8/1975, *Williams* 2033 (NBG), 600 ft., 12/11/1962, *Taylor* 4323 (PRE, STE); Windhoek Plateau, -/9/1969, v. d. *Merwe* 1010, 1011 (PRE); limestone hills near Potberg, Bredasdorp Division (-BC), 19/9/1954, *Esterhuysen* 23251 (BOL, NBG), *Blum* 267 (E), 6/5/1949, *David s.n.* (NBG); 3.3 km S. of Potberg Farm, 500 ft., 21/11/1973, *Williams* 1872 (NBG); Potberg Farm along road to the sea, 600 ft., 19/9/1979, *Williams* 2779 (NBG).

Without precise locality: in montium lateribus prope Swellendam, -/10/-, *Mund s.n.* (SAM, S), *Drège s.n.* (K).

Putative hybrids: CAPE—3420 (Bredasdorp): De Hoop—Potberg Nature Reserve, along S. foothills of limestone hills about 1.2 km due E. of De Hoop Vlei (-AD), 60 m, 28/7/1979, *Burgers* 2046 (Herb. Nat. Cons.); limestone hills above Grootfontein on W. side of De Hoop Vlei, 50 m, 3/7/1979, *Burgers* 2100 (Herb. Nat. Cons.); Windhoek farm, upper N. facing slopes of limestone hills above Die Fontein on W. side of De Hoop Vlei, 31/7/1979, *Burgers* 2097 (Herb. Nat. Cons.).

#### DISTRIBUTION AND VARIATION

*Acmadenia mundiana*, a fairly local species has only been found growing on the limestone hills between De Hoop Vlei and Potberg, a relatively small area 20 km in length. It is at the west end of this range, in the vicinity of De Hoop Vlei that this species appears to have hybridised with *Acmadenia obtusata* (Thunb.) Bartl. & Wendl. From this area C. Burgers has collected a whole range of putative hybrids showing a gradual change in leaf shape from one to the other. Amongst these are plants closely resembling *Acmadenia cucullata* which Drège collected in 1831.

*Acmadenia mundiana*, with staminodes fusiform and the small apical gland on the anther somewhat pointed, is recognised as distinct, having



leaves broad, elliptic, obtuse, scabrid, ciliate, adaxially puberulous, petiolate and alternate with a prominent midrib. It differs from other broad leaved species of *Acmadenia* as follows: from *A. rupicola* which has a large pointed gland on the anther; from *A. alternifolia* which has very long horns on the fruit; from *A. kiwanensis* which has leaves lanceolate, acute; from *A. latifolia* which has leaves and petals acute; from *A. wittebergensis* which has leaves pungent; from *A. burchellii* which has leaves lanceolate, acute and glabrous; from *A. flaccida* which has leaves opposite; from *A. densifolia*, which is also found growing on limestone hills and has leaves acute and crisped pubescent.

**21. *Acmadenia obtusata*** (Thunb.) Bartl. & Wendl., Diosmeae in Beitr. Bot. 1: 63 (1824). Type: e Cap. B. Spei, *Thunberg s.n.* (UPS-THUNB 5697, holotype; LD-ACHAR 4041/123, isotype).

*Diosma obtusata* Thunb., Prodr. Plant. Cap. 1: 84 (1794). Type: as above.

*Acmadenia juniperina* Bartl. & Wendl. Diosmeae in Beitr. Bot 1: 61 (1824). Type: without collector's name in Herb. Retzius (LD-ACHAR 4041/139, GOET-WENDL).

*Acmadenia muraltioides* Eckl. & Zeyh., Enum. Plant.: 106 (1835). Type: South Africa: Inter frutices (altit. 2) in collibus calcareis et argillaceis inter flumina Zondags—et Coegarivier (Uitenhage). —/6/—, Ecklon & Zeyher 830 (MEL, P, PRE, SAM, W).

*Macrostylis patersoniae* Schonl. in Trans. R. Soc. S. Afr. 1: 445 (1910). Type: South Africa: Red House, —/11/1908, *Paterson* 322 (BOL, K, PRE).

*Acmadenia uniflora* (Phillips) Phillips in Jl S. Afr. Bot. 9: 137 (1943). Type: CAPE—3421 (Riversdale): Buffelshoek near sea, near Albertinia, Riversdale Division (-BC/BD), —/7/1913, *Muir* 1106 (SAM, holotype; BOL, isotype).

*Euchaetis uniflora* Phillips in Ann. S. Afr. Mus. 9(3): 115 (1913). Type: as above.

*Shrubs* 0,2 m tall, grazed down, dense, flowering stems ascending, single-stemmed at base. *Branches* at first erect becoming somewhat decumbent, fairly slender, tough, short, glabrescent, variously bent; bark greyish-brown, knotty with leaf scars. *Branchlets* numerous, slender, erect, puberulous, some elongated, others very short, densely clothed with leaves, *Leaves* 10–11 mm long, 1,3–1,7 mm broad, linear-lanceolate, acute, mucronate, very short adpressed petiolate, glabrous, erect, closely imbricate or adpressed opposite and decussate or alternate; hyaline margins narrow, scabrid-serrulate; midrib prominent, sub-scabrid towards the apex, gland-dotted to either side. *Inflorescence* solitary, terminal on numerous short branchlets often crowded towards the summits of erect stems; petals spreading 10 mm

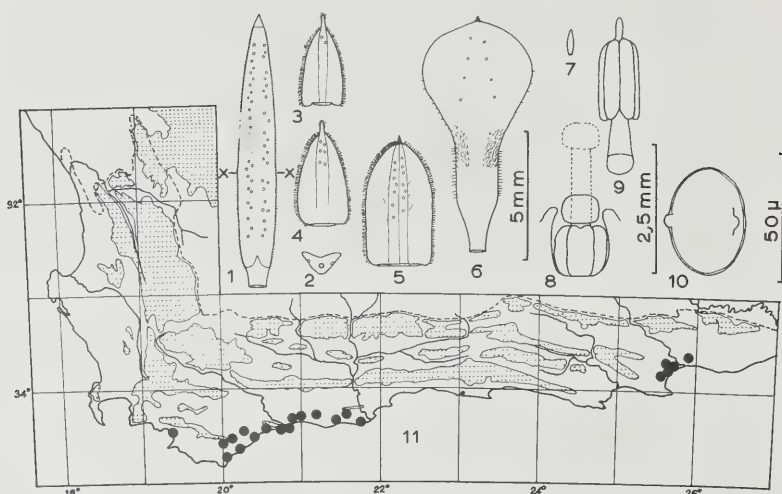


FIG. 19.

*Acmadenia obtusata*: 1, leaf. 2, section of leaf. 3, bract. 4, bracteole. 5, calyx lobe. 6, petal. 7, staminode. 8, gynoecium with disc. 9, anther. 10, pollen. 11, distribution.

diam., bright pink. *Bract* 3,5 mm long, 1,5 mm broad, oblong, acute, apiculate, glabrous, ciliate, broadly translucent, gland-dotted and coloured towards the apex; midrib prominent. *Bracteoles* two, 4 mm long, 1,8–1,9 mm broad, oblong, apiculate, glabrous, crisped ciliate, very broadly translucent; midrib towards the apex prominent, gland-dotted and coloured. *Calyx lobes* five, 5 mm long, 2,5 mm broad, oblong, obtuse, apiculate, glabrous, crisped ciliate; margins broadly translucent; midrib coloured, tri-nerved, with 2 rows of gland dots. *Petals* five, 9 mm long overall; *limb* 4–4,3 mm broad, orbicular, apiculate with a few gland dots, pink, spreading-recurved; *claw* 4 mm long, 1,5 mm broad, narrowing to the base, pubescent to either side of the midrib at the throat, sparsely ciliate above. *Staminodes* five, 0,5 mm long, somewhat fusiform, glabrous. *Filaments* five, becoming 2 mm long, stout, acicular, erect, glabrous. *Anthers* five, 2 mm long overall, 0,8 mm broad, orange-yellow; apical gland 0,4 mm long, somewhat fusiform. *Pollen* 42  $\mu$  long, 31  $\mu$  broad, ellipsoid. *Disc* obvallate, exceeds the ovary, surrounds the stigma at first, dark green, exudes nectar. *Stigma* 0,8 mm diam., capitate, globose. *Style* becoming 1,5 mm long, glabrous, erect. *Ovary* 5-carpellate, 1 mm long, 1 mm diam., virtually glabrous; apices emarginate. *Fruit* 5-carpellate, remaining partly concealed behind the persistent calyx lobes, 4 mm long, 4 mm diam., glabrous, smooth, gland-dotted, sparsely setulose

on the margins above; *horns* 0.7 mm long, emarginate. *Seed* 3.3 mm long, 1.3 mm broad, black, shining; aril black on one side.

Although Thunberg gave no locality for his collection of his *Diosma obtusata*, it seems quite possible that he collected this plant during December 1773 on his second journey into Kaffraria when he penetrated as far as the Sundays River and must have passed over the limestone deposits which are common near the coast from the Swartkops to the Coega and Sundays Rivers where this plant is abundant. It is in this same area that this plant was found by Zeyher (*Acmadenia muraltioides*), Drège (7146) and Paterson (*Macrostylis patersoniae*). The description given by Bartling and Wendland when they made the combination *Acmadenia obtusata* was based upon a plant in Willdenow's herbarium, now known as *Acmadenia laxa* Williams, which Willdenow had labeled *Diosma obtusata* 2. Consequently specimens of *A. obtusata* sensu Bartl. & Wendl. are not conspecific with those of *A. obtusata* (Thunb.) Bartl. & Wendl. The description of *Acmadenia juniperina* Bartl. & Wendl. is based upon a specimen in Retzius' herbarium at Lund. From this a fragment has been detached and can be found in Wendland's herbarium at Göttingen. The specimen at Lund, 200 mm long, is without collector's name or locality but could very possibly have been a portion of Thunberg's original collection which it exactly matches. Consequently the name *Acmadenia juniperina* Bartl. & Wendl. is relegated to synonymy.

Although separated geographically by a disjunction of approximately 360 km, plants previously thought to belong to the species *A. uniflora* cannot be satisfactorily separated from those of *A. obtusata* with the result that the name *A. uniflora* has been placed in synonymy. The above description done from fresh material from the vicinity of the Coega River supplements those previously given by other authors.

#### SPECIMENS EXAMINED

CAPE—3419 (Caledon): Dadelkom, Hermanus/Die Kelders, Caledon Division (-AD), 200 ft., 7/11/1972, *Williams* 1725 (NBG), 2/8/1973, *Williams* 1833 (NBG); Elim, Bredasdorp Division (-DB), 600 ft., 15/7/1895, *Guthrie* 3845 (NBG). —3420 (Bredasdorp): de Hoop, sand dunes, Bredasdorp Division (-AD), -/10/1969, v. d. Merwe 1183 (PRE); Windhoek farm, near Aasvoelkrans, W. side of De Hoop Vlei, 110 m, 31/7/1979, *Burgers* 2096 (STE); Lekkerwater farm, Potberg (-BC), 8/9/1973, *Powrie* 263 (BOL); Potberg farm on track to the sea, 200 ft., 19/9/1979, *Williams* 2778 (NBG); Potberg area, Elandspad farm on road to Noetsie, 300 ft., 2/7/1972, *Williams* 1668 (NBG); Potberg, Cape Infanta, Swellendam Division (-BD), 30/8/1948, *Blum* 33 (E), 23/9/1947, *Walgate* 875 (NBG); 1 mile west of Graslaagte, Heidelberg Division, 400 ft., 27/10/1972, *Williams* 1719 (NBG); Bredasdorp Poort (-CA), 2/9/1943, *Compton* 14733 (NBG), -/8/1940, *Walgate* s.n. (BOL); near Bredasdorp, 200 ft., -/7/1895, *H. Bolus* 8472 (BOL, K), 24/8/1940, *Compton* 9181 (NBG), 15/10/1951, *Esterhuysen* 19160 (BOL, NBG), -/4/1927, *Dix* s.n. (SAM), 15/9/1944, *Henrici* 3720 (BOL); 4.4 km from centre of Bredasdorp on road to Swellendam, 250 ft., 17/10/1975, *Williams* 2111 (NBG); Wagenhuiskrans, Marcus Bay, -/2-6/

1900, *Fry s.n.* (GRA, PRE); towards Bredasdorp near Arniston, 90 ft., 20/9/1968, *Marsh 924* (PRE, STE), 28/8/1956, *van Niekerk s.n.* (BOL), 30–50 ft., 17/11/1971, *Williams 1598* (NBG), 50 ft., 6/10/1972, *Williams 1697* (NBG); Zoutendalsvalley, –/10/–, *Ecklon s.n.* (MEL); 5–6 miles from Struisbaai along road to Bredasdorp, 19/9/1962, *Esterhuysen 29718* (BOL); Skipskop, Bredasdorp Division (-CB), 50 ft., 22/6/1962, *Acococks 22260* (K, PRE).

—3421 (Riversdale): 14–16 miles south of Riversdale on the Blombos road, Riversdale Division (-AC), 22/9/1959, *Lewis 5621* (NBG), 14/4/1962, *Lewis 5935* (NBG), 28/7/1968, *Acococks 24008* (PRE, STE); near Klipfontein on the Blombos road, 500 ft., 31/10/1971, *Williams 1590* (NBG); 1.8 miles S.E. of Vermaaklikheid, 400 ft., 29/7/1962, *Acococks 22526* (STE); Still Bay hills, Riversdale Division (-AD), 9/8/1949, *Barker 5535 & 5537* (NBG), –/7–8/1909, *Steyn s.n.* (BOL, PRE), *Jordaan s.n.* (STE), –/10/1933, *Jordaan s.n.* (STE), –/9/1932, *de Villiers s.n.* (STE), –/9/1934, *van Niekerk & Harvey s.n.* (STE), –/1/1931, *L. Bolus s.n.* (BOL 19480); near Milkwoodfontein, 600 ft., 7/10/1897, *Galpin 3846* (PRE); Buffelshoek near sea, near Albertinia, Riversdale Division (-BC/BD), –/7/1913, *Muir 1106* (BOL, GRA, K); Ryksdalersplaas near Albertinia (BA?), –/5/1913, *Muir 899* (BOL, SAM).

—3325 (Port Elizabeth): on the road towards Addo Road about 7 km east of Coega, Port Elizabeth Division (-DA), 6/9/1930, *Norlindh & Weimarck 515* (BOL, K, PRE); Inter frutices in collibus calcareis et argillaceis inter flumina Zondags –et Coegarivier, altit. 2, –/6/–, *Ecklon & Zeyher 830* (C, G, K, MEL, P, PRE, S, SAM, W), *Zeyher 417* (PRE, SAM), *Zeyher s.n.* (C, E, GRA, K, MEL, S); between Coega and Sundays River upon the lime flats, under 1 000 ft., 8/12/1829, *Drège 7146* (K, G, P, S, W); 2.4 miles from Coega on the Grahamstown Road, 17/3/1954, *Commings 760* (PRE); 7 miles E.N.E. of Coega, Port Elizabeth Division (-DB), 100 ft., 4/3/1948, *Acococks 14049* (PRE); Nanaga, Alexandria Division, 24/10/1941, *P. Bond 1238* (NBG); Coega (-DC), 500 ft., 17/8/1964, *Bayliss 2277* (G, NBG), –/–/1947, *Urton 721* (GRA), 150 ft., –/10/1908, *Rogers 4440* (BOL, GRA); Redhouse, Port Elizabeth Division, –/11/1908, *Paterson 322* (BOL, GRA, K, PRE), 4/9/1930, *Norlindh & Weimarck 515* (BOL, K, PRE), –/8/–, *West 116* (GRA, K), –/8/1912, *Rogers 3635* (PRE).

Without precise locality: In planitie ad pedem mts. Winterhoek in ditone Uitenhage, –/12/–, *Zeyher 417* (PRE, SAM), Prom. b. Sprei, *Thunberg s.n.* (BM?, LDACHAR, 4041/123, S?, UPS-THUNB 5697), *Auge s.n.* (BM), *Niven s.n.* (BM), *Thom 74* (K), *Baur 1014* (K), herb. Retz *s.n.* (GOET-WENDL), (LD-ACHAR 4041/139).

## DISTRIBUTION AND VARIATION

*Acmadenia obtusata* occurs fairly frequently between Bredasdorp and the mouth of the Gouritz River near Albertinia. There is a small outlier about 55 km away to the west near Walker Bay and large populations are found in the vicinity of Algoa Bay 360 km to the east. This large disjunction appears to be without reason until one studies the geological map and finds that these plants are always associated with the Bredasdorp and the related Alexandra limestone beds where a similar disjunction exists.

A certain amount of variation has been observed in this species. The leaves may be opposite or alternate and may vary in length from 5–15 mm and in width from 1–2 mm; the apex may be pungent, mucronate or in one

case obtuse (Williams 1719); the midrib may be sparsely puberulous, scabrid or almost smooth. Staminodes may vary in length from 0,2 to 0,5 mm and the apical gland on the anther similarly from 0,2–0,4 mm.

## HYBRIDS

The only hybridisation to have been observed occurs in the vicinity of De Hoop Vlei in the Bredasdorp District where C. Burgers has collected a complete range of specimens showing a gradual transition of putative hybrids from *A. obtusata* to *A. mundiana*. [Burgers 2096, 2097, 2046, 2100 (Herb. Nat. Cons.).]

*Acmadenia obtusata* is recognised as a distinct species having staminodes fusiform up to 0,5 mm long, with the apical gland on the anther similarly fusiform up to 0,4 mm long, the style erect and with leaves linear-lanceolate, acute and glabrous. It differs from *A. densifolia* which has leaves crisped pubescent; from *A. trigona* which has petals with many more gland dots; from *A. gracilis* which has calyx lobes linear-lanceolate and crisped ciliate; from *A. kiwanensis* which has leaves minutely puberulous; and from *A. laxa* which has petals puberulous.

**22. *Acmadenia maculata* Williams, sp. nov.** propria propter folia alterna lineari-lanceolata glabro-mucronata adaxialia minute maculata marginibus crassis sparsim ciliolatis subscabridis. florem petalis ad fauce approximatis gynoeccio occulto, antheras glandula minute coronata, fructum 5-carpellatum cornibus minus 2 mm longis.

*Frutex* 0,5 m altus, graciles, ad basim monocaulis. *Rami* breves, graciles, glabrescentes, flexuosi. *Ramuli* breves, graciles, minute puberuli, erecti, visibiles. *Folia* 5,5–6,3 mm longa in toto, 1,5–1,7 mm lata, lanceolata, acuta, rubromucronata, sparsim ciliolata, secus costam sparsim puberula, alterna, patentia; pagina adaxialia minute nigro-maculata; pagina abaxialia glanduloso-punctata; petioli 0,6 mm longi, puberuli. *Inflorescentia* 8 mm diam., solitaria, terminalis, numerosi, sessilis. *Bractea* 4 mm longa, 1,2 mm lata, lanceolatio-subulata, rubro-mucronata, marginibus ad basim late translucetibus, ciliolatis, intus ad basim minute nigro-maculata sparsim pubescens, extus glabra, ad costa glanduloso-punctata. *Bracteolae* duae, 3,5 mm longae, 1,5 mm latae, ovato-subulatae, rubro-mucronatae, ad apice minute glanduloso-punctatae, glabrae, intus minute nigro-maculatae, marginibus late translucetibus ciliatis. *Sepala* quinque, 3,5 mm longa, 1,5–1,8 mm lata ovata, acuta, rubro-mucronata, costa tincta ad apex prominenti; intus pubescentia, marginibus late translucetibus ciliolatis. *Petala* quinque, 6,5 mm longa in toto, fauce protuberantia; *limbus* 3 mm longus, 2,8–3 mm latus sub-orbicularis, apiculatus, glaber, roseus, patens, sparsim ciliolatus. secus



medius minute 4-elevato-glandulosus; *unguis* 3,5 mm longus 1,5 mm latus, sursum pubescens, ciliolatus. *Staminodia* quinque, 0,6 mm longa, teretia, glabra, ad apice glandulosa. *Filamenta* quinque, 1,6 mm longa, subulata, glabra, erecta. *Antherae* quinque, ante anthesin 1,2 mm longae, 0,8 mm latae, floridae, glandula 0,012 mm diam., semi-immersa coronata. *Pollen* 51  $\mu$  longum, 34  $\mu$  latum, sub-quadrangulare. *Discus* obvallatus, ovarium excedens, nectarifer. *Stigma* 0,7 mm diam., depresso-globosum, capitatum, viridum. *Stylus* 1 mm longus, glaber, erectus. *Ovarium* 5-carpellatum, 0,7 mm longum, 0,8 mm diam., glabrum, apicibus globosis. *Fructus et semen* a nobis non visa.

*Type*: CAPE—3322 (Oudtshoorn): Eensaamheid, S.E. side of a flat topped hill, George Division (-DD), 685 m (2 250 ft.) alt., 16/7/1980, *Williams 3035* (NBG, holotype; BOL, PRE, isotypes).

*Shrubs* 0,5 m tall, slender, single-stemmed at base. *Branches* short, slender, glabrescent, variously bent. *Branchlets* short, slender, minutely puberulous, erect, not hidden by the leaves. *Leaves* 5,5–6,3 mm long overall, 1,5–1,7 mm broad, lanceolate, acute, red-mucronate, alternate, spreading; margins thick, sparsely ciliolate, sub-scabrid; adaxial surface minutely dotted with black-stalked glands; abaxial surface with scattered gland dots and

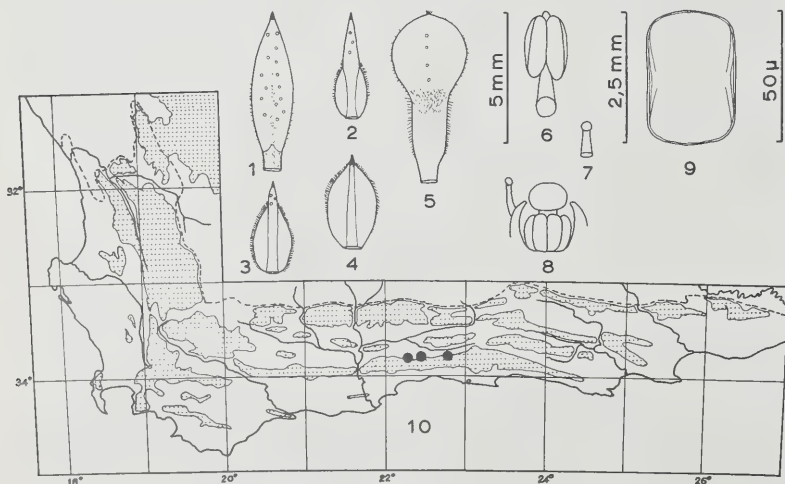


FIG. 20.

*Acmadenia maculata*: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, anther. 7, staminode. 8, gynoecium and disc. 9, pollen. 10, distribution.

sparsely puberulous along the midrib; petiole 0.6 mm long, puberulous. *Inflorescence* 8 mm diam., pink, solitary, terminal, sessile. *Bract* 4 mm long, 1.2 mm broad below, lanceolate-subulate, red-mucronate; margins ciliate, broadened and translucent below; adaxial surface sparsely pubescent in the middle below with minute black raised glands. *Bracteoles* two, 3.5 mm long, 1.5 mm broad, ovate-subulate, red-mucronate, minutely gland-dotted near the apex; margins broadly translucent, ciliolate; adaxial surface with minute black raised glands. *Calyx lobes* five, 3.5 mm long, 1.5–1.8 mm broad, ovate, acute, red-mucronate; margins ciliolate, broadly translucent; adaxially pubescent; abaxially glabrous with the midrib coloured and more prominent towards the apex. *Petals* five, 6.5 mm long overall, bulged inwards at the throat; *limb* 3 mm long, 0.8–3.0 mm broad, sub-orbicular, apiculate, glabrous, pink, spreading, very sparsely ciliolate, upper surface with about 4 minute raised glands up the middle; *claw* 3.5 mm long, 1.5 mm broad, pubescent above, ciliate. *Staminodes* five, 0.6 mm long, terete, glabrous, apex glandular. *Filaments* five, becoming 1.6 mm long, subulate, glabrous, erect. *Anthers* five, before anthesis 1.2 mm long, 0.8 mm broad, yellow; apical gland 0.012 mm diam., semi-immersed. *Pollen* 51  $\mu$  long, 34  $\mu$  broad, sub-quadrangular or oblong with parallel sides. *Disc* obovate, exceeds the ovary, green, fairly level on top, exudes nectar. *Stigma* 0.7 mm diam., depressed globose, green, sticky. *Style* becoming 1 mm long, erect, glabrous. *Ovary* 5-carpellate, 0.7 mm long, 0.8 mm diam., glabrous; apices globose. *Fruit* and *seed* not seen. An old fruit that had cast its seed (from *Williams 3032*) was found to be 8 mm long including the horns about 1.5 mm long, 5 mm diam., minutely and sparsely puberulous above.

In the type locality this plant was first collected by Miss E. Esterhuysen in July 1973. However C. Thorne, was apparently the first person to collect this species. This was in August 1931 in two localities at Doorn River and again at Great Doorn River in the George District. Of this rather distinct species with minute glandular specks on the inside of the leaves, no other collections appear to have been made until now.

#### SPECIMENS EXAMINED

CAPE—3322 (Oudtshoorn): Great Doorn River, George District (-CD), 2 000 ft., -/8/1931, *Thorne s.n.* (SAM 51690); Doorn River, George District, 2 500 ft., -/8/1931, *Thorne s.n.* (SAM 51691); North end of Perdepoort, Doringrivier, George Division, 2 530 ft., 16/7/1980, *Williams 3032* (NBG, MO, PRE, STE); Molen River, Bokkeveld hillside at Eensaamheid, George District (-DD), 23/7/1973, *Esterhuysen 33213* (BOL); Eensaamheid, S.E. side of a flat topped hill, George Division, 685 m (2 250 ft.) 16/7/1980, *Williams 3025* (NBG, BOL, PRE).

#### DISTRIBUTION AND VARIATION

*Acmadenia maculata* has been found at altitudes of between 609 and

762 m (2 000–2 500 ft.) on south-facing slopes to the north side of the Outeniqua mountains over a distance of about 50 km in the George Division. Further to the west in the vicinity of the Robinson Pass one finds *A. gracilis* Dümmer, but as far as is known no species of *Acmadenia* occurs behind the mountains further to the east. *A. maculata* appears to be extremely rare. In the type locality only three plants were seen.

A certain amount of variation has been observed in the specimens collected. Plants from the type locality have the smallest leaves and flowers and are more glabrous with the apical gland or the anther somewhat more immersed. Specimens collected by Thorne from Doorn River exhibit leaves with very long sharp points and have petals 8 mm long.

Amongst those species of *Acmadenia* with the petals close together at the throat concealing the gynoecium and with the anther bearing a small apical gland, *A. maculata* is distinct in having leaves alternate, lanceolate or linear-lanceolate, acute with a glabrous mucro, with margins thick, sparsely ciliolate and sub-scabrid, with minute black-stalked glands towards the centre of the adaxial surface and in having the fruit with horns about 1,5 mm long. It differs from *A. obtusata* which has leaves with thin translucent margins and without any black-stalked glands on the adaxial surface.

**5. ACMADENIA** sectio **ACMADENIA** Williams, sect. nov. propria propter florem pertalis ad fauce approximatis gynoecio plus minusve occulto et antheram glande apicali conoidea coronata.

Section *Acmadenia* is distinguished by having the flower with the petals at the throat close together more or less concealing the reproductive parts and with the anther crowned with a large conical gland.

Contains species:

23. *A. gracilis*
24. *A. heterophylla*
25. *A. rupicola*
26. *A. nivenii*
27. *A. sheilae*
28. *A. macropetala*
29. *A. baileyensis*
30. *A. tetragona*

**23. *Acmadenia gracilis* Dümmer** in Fedde Repert. **11**: 163 (1912). Type: CAPE—3322 (Oudtshoorn): On the ascent from Moeras River Drift, Oudtshoorn Division (-CC), 540 m (1 800 ft.), -/12/1905, *H. Bolus 11743* (K, lectotype; BOL, isotype).

*Fruit* 5-carpellate, 5 mm long, 4 mm diam., sparsely and minutely pubescent along the margins otherwise glabrous, not hidden by the calyx lobes;

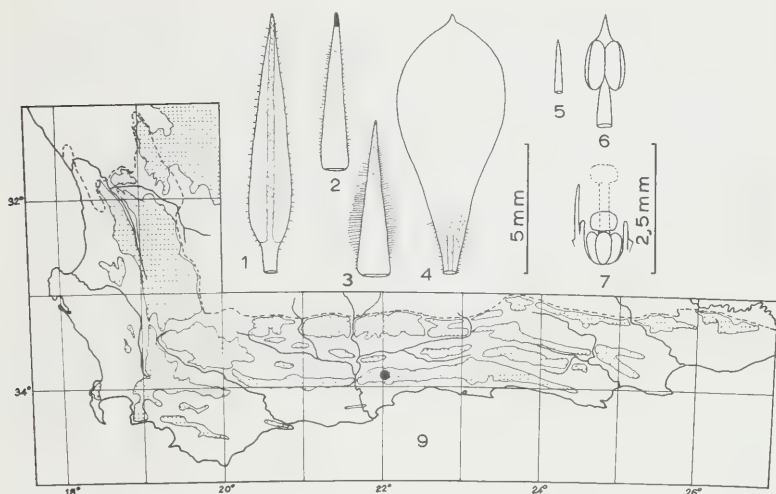


FIG. 21.

*Acmadenia gracilis*: 1, leaf. 2, bracteole. 3, calyx lobe. 4, petal. 5, staminode. 6, anther. 7, gynoecium with disc. 8, pollen. 9, distribution.

horns 0,5 mm long with an immersed gland at the apex. Seed 3,5 mm long, 1,3 mm broad, black, shining; aril black on one side.

As Dümmer cited specimens of this species at both Kew and at the Bolus herbarium without designating either as the holotype and as he states on page 120 that he was permitted to examine the material at Kew, the specimen at Kew has been chosen as the lectotype. The above description of the fruit supplements that given by Dümmer.

#### SPECIMENS EXAMINED

CAPE—332 (Oudtshoorn): On the ascent from Moeras River Drift, Oudtshoorn Division (-CC), 540 m (1 800 ft.), -/12/1905, *H. Bolus 11743* (K, (BOL, K); Robinson Pass, 22/3/1929, *Hutchinson 3149* (BM, K), 3 000 ft., 2/12/1951, *Compton 23051* (NBG), 30/6/1947, *Compton 19607* (BOL, NBG), 5/12/1950, *Barker 7139* (NBG); north side, 2 600 ft., 30/10/1971, *Williams 1570* (NBG); summit of Robinson Pass to the west behind the first summit, 3 050 ft., 5/5/1974, *Williams 1900* (NBG); Robinson Pass, mountain slopes, north side, 2/12/1951, *Esterhuysen 19312* (BOL, K, NBG).

Without locality: *Hops 88* (BOL), -/8/1912, *Rogers 4259* (GRA, K).

## DISTRIBUTION

*Acmadenia gracilis* appears to be an extremely local species having been found only at the summit and on the north slopes of the Outeniqua mountains at the Robinson Pass.

*Acmadenia gracilis* is recognised as distinct on account of having calyx lobes 6 mm long, 1,3 mm broad at base narrowing evenly to an acute apex, sparsely pubescent and ciliate, the anther with a fairly large apical gland and staminodes 1 mm long. It differs from *A. trigona* which has larger leaves, a very small gland on the anther and much broader calyx lobes; from *A. rupicola* which has leaves closely imbricate; from *A. tenax* which has the style at some stage deflexed.

**24. *Acmadenia heterophylla*** Glover in Ann. Bol. Herb. 1(3): 127 (1915). Type: CAPE—3422 (Mossel Bay): Mossel Bay (-AA), -2/1914, *Brother Moran s.n.* (BOL 13234, lectotype; SAM, isotype).

Icon: Edwards in Ann. Bol. Herb. 1(3): plate 15, fig. B (1915).

*Shrubs* up to 0,4 m tall, dense, single-stemmed at base, often grazed right down. *Branches* short, tough, variously bent, with a rough greyish-brown bark. *Branchlets* slender, erect, some very short, reddish, puberulous. *Leaves* varying 0,8 mm long and 1,4 mm broad to 4,5 mm long and

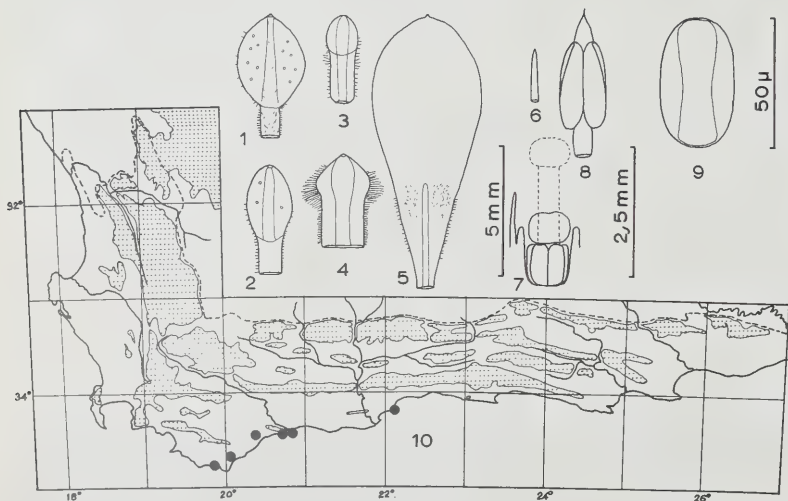


FIG. 22.

*Acmadenia heterophylla*: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, staminode. 7, gynoecium with disc. 8, anther. 9, pollen. 10, distribution.



3,4 mm broad, longer leaves being narrower, linear-elliptic, elliptic, sub-complicate, short-petiolate, spreading or spreading-erect, often imbricate, opposite, decussate or alternate, adaxially glabrous, abaxially glabrous or sparsely spiky-pubescent, gland-dotted mainly towards the midrib and margins; apex trigonal, acute, mucronate or obtuse; midrib prominent, very sparsely pubescent; margins scabrid or sparsely spiky-ciliate mainly below. *Inflorescence* solitary, terminal, 9 mm diam., pink; petals recurved. *Bract* leaf-like, petiolate. *Bracteoles* two, 3 mm long, 1,4 mm broad, oblong, apiculate, obtuse, glabrous; margins below broadly translucent, ciliate. *Calyx lobes* five, apex, 1,3 mm long, 1 mm broad, spreading, green, thick; lower part 2,5 mm long, 2,2 mm broad, ciliate, translucent at the sides. *Petals* five, 7,2 mm long; *limb* 4,7 mm long, 3,5 mm broad, ovate, obtuse with a small blunt point, sparsely gland-dotted; *claw* 2,5 mm long, narrowing to the base, sparsely ciliate, sparsely pubescent at the sides at the throat. *Staminodes* five, 0,7–1,2 mm long, acicular, glabrous; apex glandular. *Filaments* five, becoming 2 mm long, linear, glabrous. *Anthers* five, 2,3 mm long overall, 0,8 mm broad before anthesis; apical gland 0,7 mm long, conical, sticky at the tip. *Disc* obvallate, exceeds the ovary by a long way, green, exudes nectar. *Stigma* 0,8 mm diam., globose, green. *Style* becoming 1,2 mm long, glabrous, erect. *Ovary* 5-carpellate, 0,8 mm long, 0,9 mm diam., glabrous, apices faintly tri-lobed. *Fruit* 5-carpellate, 4,5 mm long, 3,5 mm diam., glabrous; *horns* 0,5 mm long, cleft at the apex. *Seed* 2,7 mm long, 1,3 mm diam., black, shining; aril small, black on one side.

Although collected by Burchell in the year 1814, this species, like many others in Burchell's herbarium, remained unnoticed until one hundred years later when a collection made by Brother Moran was described by Miss Glover in 1915. The above description done from fresh material amplifies that given by Miss Glover in the *Annals of the Bolus Herbarium*.

#### SPECIMENS EXAMINED

CAPE—3419 (Caledon): in dunis prope Brandfontein, Bredasdorp Division (-DD), 30 ft., 30/4/1897, *Schlechter 10577* (BM, BOL, E, G, GRA, MEL, P, PH, PRE, S, W); Brandfontein amongst rocks on flats half a mile from coast, 13/10/1951, *Esterhuysen 19116* (BOL); Brandfontein/Asfontein, Bredasdorp Division, 40 ft., 30/1/1973, *Williams 1756* (NBG).

—3420 (Bredasdorp): Bontebok Park, Bredasdorp Division (-CA), 17/2/1951, *Barker 7237* (NBG); Windhoek Farm, west side of De Hoop Vlei (-AD), 25 m, 23/6/1979, *Burgers 1988* (STE); Elandspad Farm, South Pottberg towards the coast at Stillegat, Swellendam Division (-BC), 100 ft., 12/4/1972, *Williams 1637* (NBG); near Cape Infanta, Swellendam Division, 28/9/1959, *Esterhuysen 28313* (BOL); behind Oysterbeds Hotel, Port Beaufort, 40 ft., 19/9/1968, *Marsh 813* (STE).

—3422 (Mossel Bay): Mossel Bay (-AA), 8/6/1929, *Salter 371/24* (BM), -/2/1914, *Brother Moran s.n.* (BOL 13234, SAM 9066); in campis prope Mossel Bay, -/9/1899, *Browne s.n.* (BOL, SAM); between the loading place at Mossel Bay and Cape St

Blaize, 23/10/1814, *Burchell* 6265 (K); Mossel Bay, macchia near Golf Course, 7/8/1936, *Lindeberg s.n.* (S); Tunnel Caves, Mossel Bay, 350 ft., 26/12/1971, *Williams* 1617 (NBG).

#### DISTRIBUTION

*Acmadenia heterophylla* appears to grow only in pockets of soil upon the Bredasdorp Limestone formation. Never very far from the coast it extends from just west of Cape Agulhas at Brandfontein to Cape St Blaize at Mossel Bay. Although it has been collected in various places to the west of Cape Infanta there appears to be a large disjunction in the distribution before it reappears again in the vicinity of Mossel Bay.

*Acmadenia heterophylla* is recognised as distinct having a small pointed anther gland and acicular staminodes, *the claw of the petal thinly pubescent at the sides*, leaves elliptic, obtuse, strongly keeled with a varying degree of spiky pubescence mainly on the midrib and margins, and the fruit glabrous with horns very short, obtuse and bifid at the apex.

**25. *Acmadenia rupicola*** Williams in Jl S. Afr. Bot. **45**(2): 163 (1979). Type: CAPE—3322 (Oudtshoorn): Robinson Pass, south side, Mossel Bay Division (-CC), 850 m alt., 6/12/1977, *Williams* 2431 (NBG, holotype).

Amongst those species of *Acmadenia* with a large conical anther-gland and with needle-like staminodes, *Acmadenia rupicola* is distinct in having alternate leaves.

**26. *Acmadenia nivenii*** Sonder in Fl. Cap. **1**: 380 (1860). Type: Prom. b. Spei, *Niven s.n.* (BR-MART, lectotype; S, isotype).

*Shrubs* 0,3–0,4 m tall, single-stemmed at base; one plant in ground not so recently burnt, 1 m tall, showed about 17 growth rings in a section of the stem about 12 mm diam. *Branches* not very numerous, lax, glabrous, bark greyish-brown, fairly smooth with small leaf scars. *Branchlets* fairly erect at first, not numerous, slender, mostly hidden by the appressed leaves, reddish and glabrous where exposed, very sparsely pubescent where protected by the leaves, often opposite. *Leaves*, on seedlings and young plants the lowest leaves are imbricated in 4 rows, when mature 6–8 mm long, 1–1,4 mm broad, linear-elliptic, obtuse, callused, crisped ciliate, glabrous, gland-dotted, sessile, appressed erect, opposite, decussate; margins narrowly translucent. *Inflorescence* solitary, terminal on short branchlets of varying length; *flowers* about 20 mm diam., pink to red with a dark red midrib. *Bracts*, below the bracts are two pairs of reduced leaves about 3,5 mm long, the flower readily breaks off above the two bracts which are 4,4 mm long, 2 mm broad, broadly lanceolate or elliptic, glabrous; midrib green, gland-dotted, prominent with a blunt point; margins crisped ciliate, broadly trans-

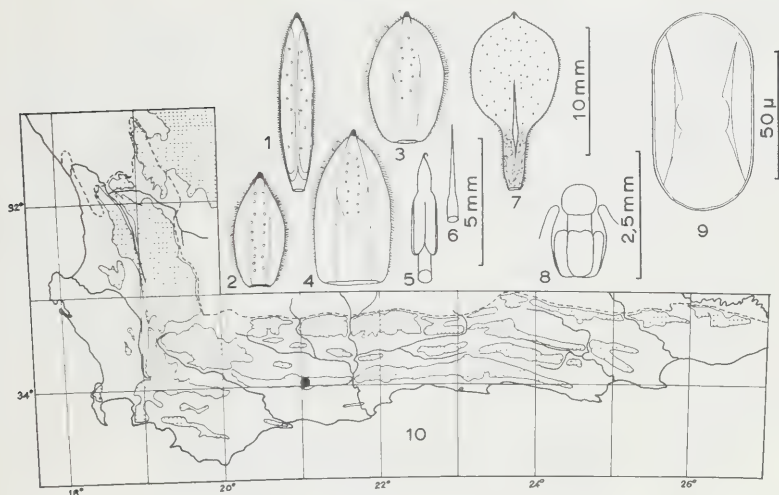


FIG. 23.

*Acmadenia nivenii*: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, anther. 6, staminode. 7, petal. 8, gynoecium with disc. 9, pollen. 10, distribution.

lucent. *Bracteoles* two, 5 mm long, 3 mm broad, elliptic, glabrous, coloured; margins crisped ciliate, broadly translucent; midrib green, gland-dotted, prominent with a blunt elevated point. *Calyx lobes* five, 6 mm long, 3 mm broad, oblong-elliptic, glabrous, coloured; margins crisped ciliate, broadly translucent; midrib green, gland-dotted, prominent with a blunt elevated apex. *Petals* five, 14 mm long overall; *blade* 9.5 mm long, 7 mm broad, orbicular, spreading, glabrous, multi-gland-dotted, ciliolate, somewhat apiculate with the apex minutely gibbous, midrib reddened below; *claw* 4.5–5 mm long, 2 mm broad above, narrowing to the base, ciliate, adaxially pubescent. *Staminodes* five, 2.6 mm long, acicular, glabrous, glandular translucent above, erect. *Filaments* five, becoming 3 mm long, acicular, glabrous, erect. *Anthers* five, before anthesis, 4 mm long overall including the apical gland, 1 mm broad, orange-red; apical gland stout, sharply pointed and hooked at the tip which exudes nectar. *Pollen* 78 μ long, 40 μ broad, oblong. *Disc* narrow, green, exceeds the ovary by a long way, touches the stigma. *Style* becoming 1.5–1.8 mm long, erect, green, glabrous, persisting. *Ovary* carpellate, 0.9 mm long, 1 mm diam., glabrous, green, apices somewhat emarginate. *Fruit* 5-carpellate, more than half concealed by the persistent calyx lobes, 8–8.2 mm long, 5–5.4 mm diam., quite glabrous, gland-dotted mainly towards the margins; *horns* very short, erect, emarginate, 1.5–2 mm

long; pedicel about 1 mm long or much less. *Seed* 5–5.2 mm long, 1.8–1.9 mm broad, black, shining; aril black on one side.

This plant was collected by James Niven at the beginning of the century and, as was very often the case, no locality was given. Sonder, when revising the Rutaceae for the *Flora Capensis*, recognised Niven's specimen, which was in Maritius' herbarium, to be a distinct species and detached a portion for his herbarium. No further material belonging to this species appears to have been collected until in November 1978 when it was rediscovered by Mrs P. A. Bean on the northern slopes of the Gysmanshoek Pass in the Langeberg north of Heidelberg. A collection made by R. A. Haynes in September 1978, although preceding that of Mrs A. Bean, was not brought to my attention until this manuscript was being typed out in August 1980. As Niven's specimen had been in bud, the rediscovery of this species has enabled the above more detailed description to be made from fresh material.



FIG. 24.

*Acmadenia nivenii*: Dissection of flower showing anthers with large pointed apical glands.

#### SPECIMENS EXAMINED

CAPE—3321 (Ladismith): north side of Gysmanshoek Pass, Heidelberg Division (-CC), 2 000–2 400 ft., 22/9/1978, *Bean* 132 (BOL), 17/10/1978, *Williams* 2613 (NBG), 4/12/1978, *Williams* 2655 (NBG); Garcia State Forest, Langeberg Mountains, N. slopes west of Garcia Pass, c. 1 900 ft., 26/9/1978, *Haynes* 1453 (Wicht Herbarium, Jonkershoek).

Without locality: Promont. b. *Spei*, *Niven* s.n. (BR-MART 1128, lectotype; S, isotype).

#### DISTRIBUTION

*Acmadenia nivenii*, although quite frequent locally on the northern

slopes of the Langeberg at Gysmanshoek Pass, appears to have a very limited distribution, not being found as far to the east as Garcia's Pass, nor as far to the west as Tradouw Pass.

Amongst those species of *Acmadenia* with a large conical anther-gland and with needle-like staminodes, *Acmadenia nivenii* is distinct in having leaves opposite, decussate, adpressed erect, sessile, linear-elliptic, obtuse, callused, crisped ciliate, and with many small gland dots.

**27. *Acmadenia sheilae*** Williams in J1 S. Afr. Bot. **40**(4): 281 (1974). Type: Cape Province, Ladismith Division, Roodeberg, near Van Wyk's Dorp, 4 000 ft., 1/11/1931, *Compton 3859* (BOL, holotype; K, isotype).

*Acmadenia gracilis* Compton in J. Bot., Lond. **70**: 285 (1932) nom. illegit. non Dümmer (1912) Type: as above.

Amongst those species of *Acmadenia* with a large conical anther-gland and with needle-like staminodes, *Acmadenia sheilae* is distinct in having leaves opposite, decussate, oblong, obtuse, eciliate or sparsely ciliate and short-petiolate. Its distribution extends from the Roodeberg to the Swartberg and on to the Touwsberg.

**28. *Acmadenia macropetala*** (Glover) Compton in J. Bot., Lond. **70**: 286 (1932). Type: CAPE—3421 (Riversdale): Hills around Albertinia, Riversdale Division (-BA), -/6/1913, *Muir 930* (BOL, lectotype; GRA, K, isotypes).

*Acmadenia obtusata* Bartl. & Wendl. var. *macropetala* Glover in Ann. Bol. Herb. **1**(3): 127 (1915). Type: as above.

Icon: Edwards in Ann. Bol. Herb. **1**(3): plate 15, fig. A. (1915).

*Shrubs* about 0.5 m tall, diffuse, spreading amongst other vegetation, single-stemmed at base; a lower branch showed 20 growth rings. *Branches* slender, lax, glabrous, fairly smooth, leaf scars inconspicuous, bark brownish-grey. *Branchlets* very slender, fairly long, puberulous, never quite straight. *Leaves* 3.3–7 mm long, 1.3–1.7 mm broad, lanceolate, obtuse, virtually sessile, ciliate, glabrous, adpressed erect, opposite, decussate, adaxially concave, abaxially round keeled, multi-gland-dotted. *Bud* acute, pink. *Inflorescence* 20 mm diam., solitary, terminal between a pair of incipient branchlets. *Bracts* two, opposite, leaf-like, 2.5 mm long, 1.5 mm broad, ovate-lanceolate, obtuse, glabrous, adpressed; margins ciliate, broadly translucent; abaxially round-keeled. *Bracteoles* two, 3 mm long, 1.7 mm broad, ovate-lanceolate, obtuse, adpressed, glabrous; midrib prominent rounded, gland-dotted; margins ciliate, broadly translucent. *Calyx lobes* five, 4.4 mm long, 2 mm broad, oblong, obtuse; margins broadly translucent, pink, ciliate; midrib rounded, green, gland-dotted in two rows: adaxial surface very sparsely pubescent in the middle below. *Petals* 10–12 mm



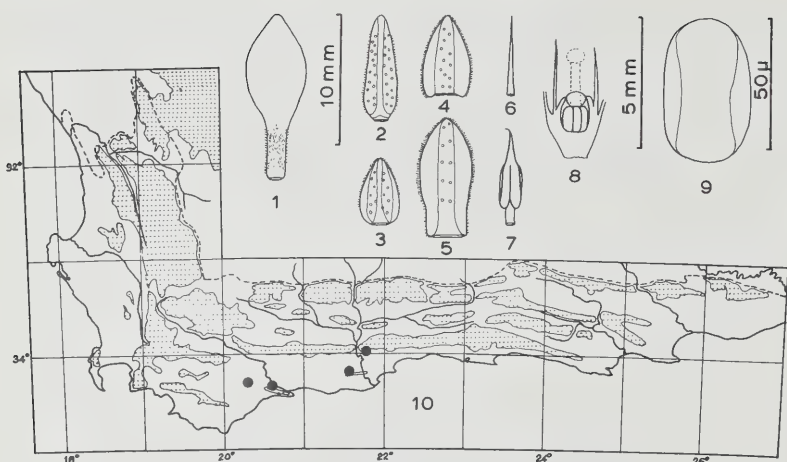


FIG. 25.

*Acmadenia macropetala*: 1, petal. 2, leaf. 3, bract. 4, bracteole. 5, calyx lobe. 6, staminode. 7, anther. 8, gynoecium with disc, staminode and filament. 9, pollen. 10, distribution.

long; *limb* 7 mm long, 4,7 mm broad, elliptic, obtuse, glandular apiculate, gland-dotted in two rows, spreading; *claw* 3–4 mm long, 1,6 mm broad, pubescent, ciliolate. *Staminodes* five, up to 3 mm long, acicular, glabrous. *Filaments* five, becoming 2,5 mm long, erect, acicular, glabrous. *Anthers* five, 1,7 mm long, 0,8 mm broad, red/yellow; apical gland 1,2 mm long, conical, incurved above. *Pollen* 55  $\mu$  long, 33  $\mu$  diam., oblong. *Disc* obvalate, exceeds the ovary, surrounds the stigma at first. *Stigma* 0,7 mm diam., globose, capitate, green. *Style* becoming 1,7 mm long, terete, glabrous, erect. *Ovary* 5-carpellate, 1 mm diam., glabrous. *Fruit* 5-carpellate, 7 mm long, 4,5 mm diam., pubescent between the carpels; *horns* 1–2 mm long, emarginate. *Seed* 4,7 mm long, 1,5 mm broad, black, shining; aril black on one side.

When Miss Glover described this plant as a variety of *Acmadenia obtusata* Bartl. & Wendl., she confined her diagnosis to a description of the petal alone. Fortunately this was accompanied by an excellent drawing by G. Edwards which leaves no doubt as to the identity of the plant. In raising this variety to species level Compton gave no further information. The above detailed description, done from fresh material is therefore the first to be given of this plant.

## SPECIMENS EXAMINED

CAPE—3420 (Bredasdorp): hills 1 km east of the Bredasdorp/Swellendam road near Vrede, Swellendam Division (-AD), 290 m (950 ft.) alt., 12/8/1973, *Williams 1844* (NBG); Potberg mountain, northern side above Diepkloof, Swellendam Division (-BC), 330 m, 20/6/1979, *Burgers 1968* (STE).

—3421 (Riversdale): hills around Albertinia, Riversdale Division (-BA), -/6/1913, *Muir 930* (BOL, GRA, K); Albertinia near cemetery, Riversdale Division, 600 ft., 6/7/1973, *Williams 1822* (NBG).

—3321 (Ladismith): Cloete's Pass, Mossel Bay Division (-DD), *Muir 2927* (BOL).

## DISTRIBUTION

*Acmadenia macropetala* has been very seldom collected. Such collections as have been made are from relic patches of quartzitic rocks associated with ochreous clay and geographically very widely separated.

Amongst those species of *Acmadenia* with a large conical anther-gland and with needle-like staminodes, *Acmadenia macropetala* is distinct having leaves opposite, decussate, lanceolate, obtuse, ciliolate, adpressed erect, with many gland dots.

**29. *Acmadenia baileyensis*** Williams, sp. nov. earum glandula antherae conica staminodiisque acicularibus propria propter folia oblanceolata obtusima, filamenta staminodiaque sparsim pubescentia.

*Frutex* 0,5 m, ad basim monocaulis. *Rami* aliquanti, brevi, erecti, glabrescentes. *Ramuli* numerosi, brevi, erecti, puberuli, foliosi. *Folia* 6 mm longa, 2,3 mm lata, oblanceolata, trigono-obtusa, glabra, opposita, decussata, erecta, imbricata, in sicco sub-complicata, breve petiolata, marginibus serrulatis, sparsim ciliolatis. *Inflorescentia* 17 mm diam., solitaria, terminalia, rosea. *Bractee* duae, oppositae, 4,2 mm longae, 3,2 mm latae, late oblanceolatae, obtusae, ad apice forte carinatae, pauci glanduloso punctata, marginibus late hyalinis ad basim ciliatis. *Bracteolae* duae, 4,8 mm longae, 3,5 mm latae, late oblanceolatae, trigono-obtusae, ad apice forte carinatae, glabrae, glanduloso-punctatae, ad basim late hyalinae. *Sepala* quinque, 5–5,6 mm longa, 2,8–4,2 mm lata, late lanceolata, obtusa, intus pubescentia, glanduloso-punctata, apicibus recurvo-carinatis, marginibus ciliatis, late hyalinis. *Petala* quinque, in toto 14 mm longa; *limbus* 8 mm latus, orbiculare, glanduloso-punctatus, apice minute glanduloso-apiculato, marginibus ad basim sparsim ciliolatis; *unguis* 6 mm longum, pubescens, sparsim ciliolatum. *Staminodia* quinque, 2,5 mm longa, acicularia, sparsim pubescentia. *Fila* quinque, 3,2 mm longa, acicularia, sparsim pubescentia. *Antherae* quinque, in toto 2,2 mm longae, glandulis apicalibus 0,7 mm longis. *Pollen* 58  $\mu$  longum, 42  $\mu$  latum, ellipticum. *Discus* obvallatus, ovarium excedens, viridus, angustus, sinuatus. *Stigma* 1 mm diam., globosum, viridum. *Stylus* 1,7 mm longus, erectus, glaber. *Ovarium* 5-carpellatum, 1 mm longum, 1,2 mm diam., glabrum, carpellis obtusis emarginatis.

*Type:* CAPE—3321 (Ladismith): north slopes of Bailey Peak, Rooiberg, Ladismith Division (-CB), 1 280 m (4 200 ft.) alt., 3/11/1975, *Williams 2136* (NBG, holotype).

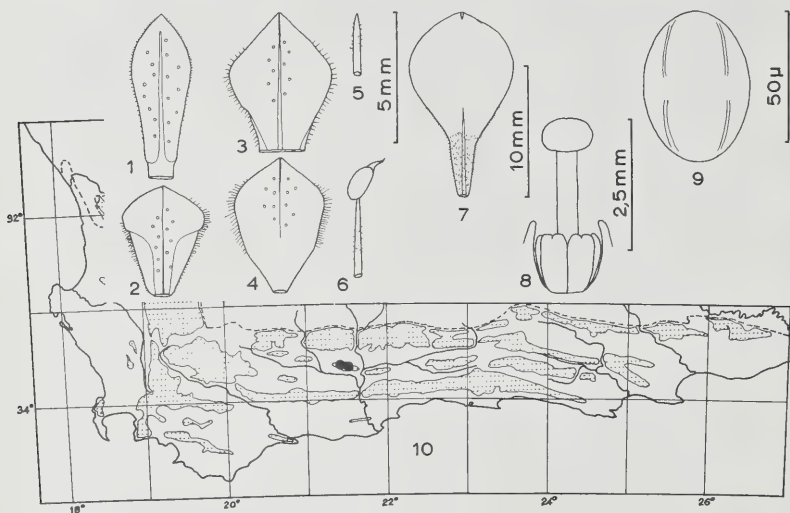


FIG. 26.

*Acmadenia baileyensis*: 1, leaf. 2, bract. 3, calyx lobe. 4, bracteole. 5, staminode. 6, anther, side view after anthesis. 7, petal. 8, gynoecium and disc. 9, pollen. 10, distribution.

*Shrubs* 0,5 m tall, single-stemmed at base. Branches fairly numerous, short, erect, glabrescent; leaf scars not prominent. *Branchlets* numerous, short, erect, puberulous, well clothed with leaves. *Leaves* 6 mm long overall, 2,3 mm broad, oblanceolate, trigonal-obtuse, glabrous, erect, imbricate, opposite, decussate, sub-complicate when dry; margins serrulate, sparsely ciliolate; petiole 0,7 mm long. *Inflorescence* solitary, terminal, 17 mm diam., pink. *Bracts* two, opposite, 4,2 mm long, 3,2 mm broad, broadly oblanceolate, obtuse, strongly keeled above, broadly translucent and ciliate below; gland dots few, indistinct. *Bracteoles* two, 4,8 mm long, 3,5 mm broad, broadly oblanceolate, obtuse, strongly keeled above, apex 3-angled, glabrous, gland-dotted, ciliate, broadly translucent below. *Calyx lobes* five, 5–5,6 mm long, 2,8–4,2 mm broad, broadly lanceolate, obtuse, apex keeled and recurved; abaxially glabrous, gland-dotted; adaxially pubescent about the middle; margins ciliate at the sides, broadly translucent. *Petals* five, 14 mm long overall; *limb* 8 mm broad, orbicular, gland-dotted; apex minutely

glandular apiculate; margins below sparsely and minutely ciliate; *claw* 6 mm long, narrowing to the base, internally pubescent, sparsely ciliate. *Staminodes* five, 2,5 mm long, acicular, sparsely pubescent. *Filaments* five, 3,2 mm long, acicular, sparsely pubescent. *Anthers* five, 2,2 mm long overall including the conical apical gland 0,7 mm long. *Pollen* 58  $\mu$  long, 42  $\mu$  broad, elliptic. *Disc* obvallate, narrow, sinuate, green, exceeds the ovary. *Stigma* 1 mm diam., globose, green. *Style* 1,7 mm long, glabrous, erect. *Ovary* 5-carpellate, 1 mm long, 1,2 mm diam., glabrous; carpels obtuse, emarginate. *Fruit* and *seed* not seen.

This plant was discovered in November 1975 on the north slopes of Bailey Peak near the summit in the Rooiberg near Ladismith. At the time it was thought to be *Acmadenia sheilae*. However at a later date it was noticed that the shape of the leaves appeared to be somewhat different and the filaments and staminodes were found to be sparsely pubescent. There seems to be no doubt that it is a vicarious species in the group containing *A. sheilae*, *A. nivenii*, *A. macropetala* and *A. tetragona* all of which occupy distinct but not overlapping geographical areas.

#### SPECIMENS EXAMINED

CAPE—3321 (Ladismith): north slopes of Bailey Peak, Rooiberg, Ladismith Division (-CB), 1 280 m (4 200 ft.) alt., 3/11/1975, *Williams* 2136 (NBG); Rooiberg just N. of "TV plateau" on the property "Rooigrond". TR 439, Ladismith Division (-DA), c. 4 250 ft., 20/4/1977, *Taylor* 9624 (STE).

Amongst those species of *Acmadenia* with a large conical anther-gland and with needle-like staminodes, *Acmadenia baileyensis* is distinct in having leaves opposite, decussate, sub-complicate, oblanceolate and very obtuse and in having the filament and staminode very sparsely pubescent.

**30. *Acmadenia tetragona*** (Linn. f.) Bartl. & Wendl. Diosmeae in Beitr. Bot. 1: 65 (1824). Type: Cap. bonae spei. *Sparrmann* (S, lectotype; S, LD, isotypes).

*Diosma tetragona* Linn. f., Suppl. Plant.: 155 (1781). Type: as above.

*Bucco tetragona* Roem. & Schult., Syst. veg 5: 444 (1819) in part.

*Acmadenia strobilina* E; Mey. in Drege, Zwei Pflanz. Doc.: 117, 161 (1844) nom. nud.

*Shrubs* 0,3 to 0,6 m tall, spreading, single-stemmed at base. *Branches* short, fairly erect, clothed with a short erect pubescence, knotty with leaf scars. *Branchlets* fairly numerous, short, erect, hidden by the leaves, erect pubescent. *Leaves* strongly keeled, the two halves of the blade set at an angle, orbicular when pressed flat, 4,8 mm long, 4,2 mm broad, minutely pubescent, gland-dotted, ciliate, adaxially glabrous, opposite, decussate,

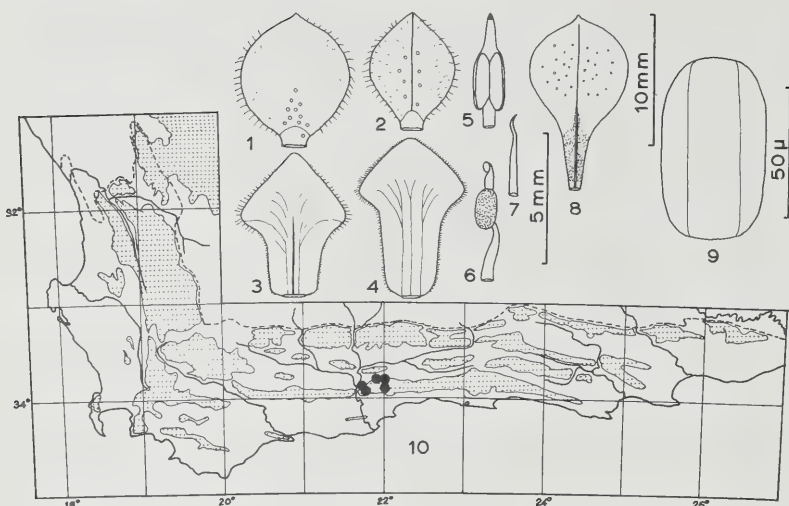


FIG. 27.

*Acmadenia tetragona*: 1, leaf flattened out. 2, leaf. 3, bracteole. 4, calyx lobe. 5, anther. 6, anther, side view after anthesis. 7, staminode. 8, petal. 9, pollen. 10, distribution.

spreading; apex trigonal obtuse; petiole very short. *Inflorescence* terminal, solitary, 20–25 mm diam., white with a red midrib. *Bracts* four, 5,5 mm long, 4 mm broad, keeled, minutely pubescent, gland-dotted, ciliate; margins broadly translucent below. *Calyx lobes* five, 6 mm long, 4 mm broad, keeled, sparsely pubescent and purplish above; apex obtuse, trigonal; tri-nerved, pale, glabrous and translucent below. *Petals* five, 13,5 mm long, 7,8 mm broad; *limb* spreading, orbicular, apiculate, minutely ciliate, abaxially multi-gland-dotted, narrowing below; *claw* about 4 mm long, narrowing towards the base, ciliate, adaxially pubescent, midrib prominent. *Staminodes* five, 3 mm long, 0,3 mm diam., acicular, glabrous, apex glandular. *Filaments* five, 3 mm long, 0,5 mm diam., acicular narrowing above, glabrous. *Anthers* five, before anthesis 2,3 mm long, 1,2 mm broad, orange tinged with red; apical gland 1,5 mm long, greenish and incurved at the glandular apex. *Pollen* about 69 µ long, 41 µ broad, oblong. *Disc* obvallate, a narrow rim level on top equalling the top of the stigma at first, green, exudes nectar. *Stigma* 0,8 mm diam., capitate, globose, dark green. *Style* becoming 1 mm long, persistent. *Ovary* 5-carpellate, 1 mm diam., apex pubescent. *Fruit* 5-carpellate, surrounded two-thirds of the way up by the persistent calyx lobes, 7,5 mm long, 4,7 mm diam., fringed with short spiky hairs on the



margins and at the apex, gland-dotted; *horns* 1 mm long, erect, extremely short, without any apical gland. *Seed* 5 mm long overall, 1.8 mm broad, black, shining; aril black on one side.

The first person to collect *Acmadenia tetragona* was probably C. P. Thunberg when he passed through Attaquaskloof on his second journey to Kaffraria in the year 1773. However it was Anders Sparrmann, who travelled through Attaquaskloof two years later and collected the same plant, whose specimen was used to name this plant. A part of his collection was seen by Linnaeus whose son later published the description of *Diosma tetragona* in the *Supplementum Plantarum* in 1781. No type specimen remains in Linnaeus' herbarium but in Smith's herbarium housed at the Linnean Society in London one finds a fragment without collector's name labelled *HL fil.* which may be the original type or at least an isotype. Duplicates of Sparrmann's collection of *tetragona* are to be found at Lund (LD) and at Stockholm (S) and of these one sheet at Stockholm, inscribed on the reverse *Diosma tetragona* Cap.B.Sp. Sparrmann, has been chosen as the lectotype.

In Thunberg's herbarium No. 5716 *Diosma tetragona* is made up of a mixed collection of *Euchaetis pungens* and *Acmadenia tetragona*. His No. 5717 *Diosma tetragona* consists of two twigs of *A. tetragona*. So it is quite understandable that Thunberg's description should refer more or less to *Euchaetis pungens* and that Roemer & Schultes who transferred *Diosma tetragona* to *Bucco tetragona* should have found that the descriptions of Thunberg and of Linnaeus fil. did not agree.

E. Meyer, in going through Drège's collections, gave this little-known plant the manuscript name of *Acmadenia strobilina*.

The above description done from fresh material amplifies those previously given.

#### SPECIMENS EXAMINED

CAPE—3321 (Ladismith): 3 miles from Grootplaas on road to Woeska, Mossel Bay Division (-DC), 1 050–1 750 ft. alt., 3/11/1975, Williams 2142 (NBG); stony places in Attaquaskloof (-DD), 1 500–2 000 ft. (IV, A, 17) 22/5/1833, Drège s.n. (BM, E, G, K, MEL, P, PRE, S); upper slopes of Langeberg, Cloetes Pass, Mossel Bay Division, -/7/1913, Muir 977 (BOL). -/6/1914, Muir 1403 (SAM); Attaquaskloof, Dr. Gill s.n. (K); Cloetes Pass, 10/8/1952, Hall 538 (NBG). —3322 (Oudtshoorn): Robinson Pass (-CC), 9/6/1929, Salter 376/26 (BM, K), 2 000 ft., 27/11/1949, Compton 21836 (NBG), 2 250 ft., 27/5/1956, Heginbotham 322 (NBG); Robinson Pass, north side, Oudtshoorn Division, -/8/1905, A. Taylor s.n. (BOL 10585, GRA, K), Hops 71 (BOL), 2 600 ft., 30/10/1971, Williams 1569 (NBG); top of Robinson Pass, Mossel Bay/Oudtshoorn, 30/6/1947, Compton 19593 (BOL, NBG), 2 600 ft., 2/8/1959, Acocks 20584 (K, PRE), 22/10/1962, Killick 3472 (K, PRE); Robinson Pass, south side, Mossel Bay Division, 1 000–2 500 ft., 2/12/1951, Esterhuysen 19303 (BOL, NBG), 2 450 ft., 5/5/1974, Williams 1899

(NBG); foothills N. side of Outeniquas near Moeras River, 6/12/1951, *Esterhuysen* 19440 (BOL); Kruispad, Oudtshoorn Division, 24/11/1949, *Compton* 21752 (NBG); Ruytersboch, Mossel Bay Division, -/9/1909, *Britten* 137 (GRA); Berg Pass, Mossel Bay Division, 4/4/1959, *Barker* 8924 (NBG), 5/4/1959, *Barker* 8929 (NBG).

Without locality: Cap.B.Spei., *Niven* s.n. (BM, BR-MART), *Roxburgh* 10 (BM, G), prope Georgetown, -/10/1905, *Hops* s.n. (BOL 10442), *Hesse* s.n. (GOET-WENDL, MEL), *Thunberg* s.n. (LINN-SMITH 397/2), *Sparrmann* ? s.n. (LINN-SMITH 397/3), *Sparrmann* s.n. (LD, S), *Thunberg* s.n. (UPS 5716/c), (UPS 5717).

Amongst those species with a large conical anther-gland and with needle-like staminodes, *Acmadenia tetragona* is distinct in having leaves opposite, decussate, complicate, strongly keeled and sub-orbicular when pressed flat. Its distribution appears to be limited to the Outeniqua Mountains from Cloetes Pass to the Robinson Pass. It is commonly known as the Pagoda flower.

**6. ACMADENIA** sectio **ALBIFLOS** Williams, sect. nov. propria propter florem petalis niveis ad fauce approximatis et fructos carpellis ad apicibus bifidis.

Section *Albiflos* is distinguished by having flowers with snow white petals, bulged inwards at the throat and fruits with carpels bifid at the apex.

Contains species:

31. *A. faucitincta*

32. *A. nivea*

33. *A. candida*

**31. Acmadenia faucitincta** Williams, sp. nov., propria propter florem ad faucem tinctam et in omnes partes quam illis *A. niverarum* et *A. candidarum* grandiore.

*Frutex* graciles. *Rami* pauci, laxiusculi, graciles, glabri, leves, sparsim 2-chotomi. *Ramuli* pauci, graciles, breves, erectiusculi, glabri, foliis occultis. *Folia* 5,5–8,5 mm longa, 1,4–2 mm lata, lanceolata, obtusa, sessilia, glabra, opposita, 4-faria, imbricata, erecta, rubescentia, pauci glanduloso-punctata, marginibus late translucetibus ciliatis vel eciliatis. *Inflorescentia* terminalis; *flos* 12 mm diam., 2,5 mm pedicellatus, bini vel quaterni. *Bractea* 7,2 mm longa, 2,2 mm lata, folio simili. *Bracteolae* duae, 5 mm longae, 1,5 mm latae, oblongae, glabrae, indistincte glanduloso-punctatae; costis sparsim pubescentibus; apicibus incrassatis purpurascetibus; marginibus late translucetibus ciliatis. *Sepala* quinque, 5,2–5,8 mm longa, 2,6–3 mm lata, elliptica, obtuso-apiculata, glabra, purpurascetia, sparsim glanduloso-punctata, marginibus late translucetibus ciliatis. *Petala* quinque, 11,5 mm longa; *limbus* 5 mm diam., orbicularis, apiculata, glaber, niveus, patens; *unguis* 6 mm longus, glaber, tinctus. *Staminodia* quinque, 0,6 mm longa, glabra; glandula, 0,2 mm diam. coronata. *Filamenta* quinque, 2 mm longa, glabra, acicularia,

erecta. *Antherae* quinque, ante anthesin 1,8 mm longae, 0,7 mm latae, subroseae; glandula 0,15 mm diam. coronata. *Pollen* 62  $\mu$  longum, 32  $\mu$  latum, oblongum. *Discus* obvallatus, ovarium excedens. *Stigma* 0,6 mm diam., depresso-capitatum. *Stylus* brevis, glaber, erectus. *Ovarium* 5-carpellatum, 8 mm diam., glabrum; *carpellum* ad apicem bifidum scabridum. *Fructus* et *semen* a nobis non visa.

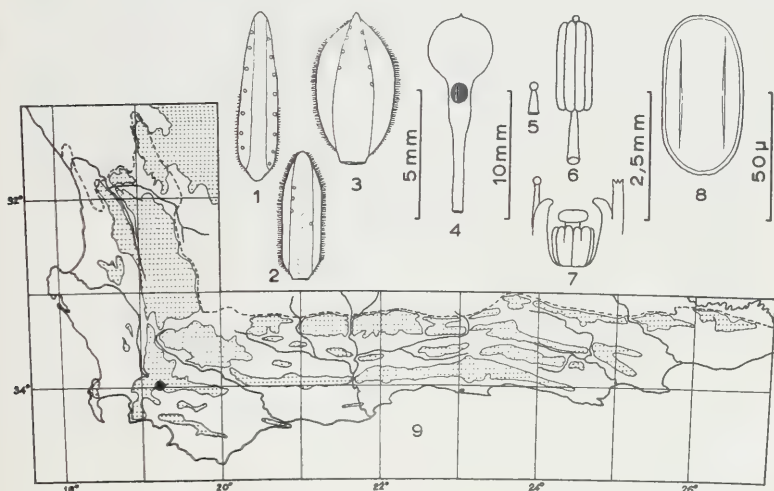


FIG. 28.

*Acmadenia faucitincta*: 1, leaf. 2, bracteole. 3, calyx lobe. 4, petal. 5, staminode. 6, anther. 7, gynoecium and disc. 8, pollen. 9, distribution.

*Type*: CAPE—3319 (Worcester): Blokkop above Villiersdorp, Caledon Division (-CD), 5/11/1978, Esterhuysen 35110 (BGL, holotype).

*Shrubs* slender, amongst bush and restios. *Branches* few, somewhat lax, slender, glabrous, smooth, leaf scars not prominent, dichotomously branched. *Branchlets* few, slender, short, somewhat erect, glabrous, hidden by the leaves. *Leaves* 5,5–8,5 mm long, 1,4–2 mm broad, lanceolate, obtuse, glabrous, opposite, decussate, imbricate, erect, sessile, reddened; abaxial surface smooth with few indistinct gland dots to either side, with the midrib rounder and somewhat translucent; translucent margins ciliate becoming eciliate. *Inflorescence* terminal; *flowers* 12 mm diam., white with the pedicel about 2,5 mm long, usually in groups of two opposite pairs. *Bract* 7,2 mm long, 2,2 mm broad, leaf-like at base of pedicel. *Bracteoles* two, 5 mm long,

1,5 mm broad, oblong, halfway up the pedicel, glabrous except for a few hairs on the lower part of the midrib; apex purplish, thickened; margins ciliate, broadly translucent, one or two indistinct gland dots towards the inner side. *Calyx lobes* five, 5,2–5,8 mm long, 2,6–3 mm broad, elliptic, obtuse-apiculate, glabrous, reddened above, ciliate, gland dots in two rows above, margins broadly translucent. *Petals* five, 11,5 mm long overall; *limb* 5 mm diam., orbicular, apiculate, glabrous, snow-white, spreading; *claw* 6 mm long, 1,7 mm broad above, 0,7 mm broad at base, glabrous, bulged inwards at the throat where a more or less round coloured patch can be seen. According to Miss Esterhuysen "Claws of petals olive-green below, purple-red-brown above, bordered with dull off-white, and form a very conspicuous centre". *Staminodes* five, 0,6 mm long, glabrous, narrowing above to a globose apical gland 0,2 mm diam. *Filaments* five, 2 mm long, glabrous, acicular, erect. *Anthers* five, 1,8 mm long, 0,7 mm broad, somewhat pinkish; apical gland about 0,15 mm diam., globose, very short stipitate. Pollen 62  $\mu$  long, 32  $\mu$  broad, oblong. *Disc* obvallate, exceeds the ovary by a long way closing slightly over it, level on top, pale green. *Stigma* 0,6 mm diam., capitate, disc-shaped. *Style* short, glabrous, erect. *Ovary* 5-carpellate, 8 mm diam., glabrous; apices 2-lobed, scabrid. *Fruit* and *seed* not seen.

As far as is known this species has only been collected once and that was by Miss Elsie Esterhuysen in November 1978. Its great interest lies in the fact that it forms part of a series of three very similar plants all from the high mountains of the extreme South west Cape, which show a progressive reduction in size of the floral parts and in the number of carpels in the ovary. *A. faucitincta*, *A. nivenea* and *A. candida* have each 5, 3 and 2 carpels in the ovary in that order.

#### SPECIMENS EXAMINED

Type only; as above.

*Acmadenia faucitincta* is recognised as distinct having the throat of the flower strikingly coloured. Of those species with snow-white flowers and bifid carpels, *A. faucitincta* is also distinct in having a 5-carpellate ovary and in having flowers and all floral parts much larger.

**32. *Acmadenia nivea*** Williams in Jl S. Afr. Bot. **44**(4): 350 (1978). Type: CAPE—3418 (Simonstown): marshy ground, peaty soil, amongst restioids, Steenbras catchment area, Kogelberg, Caledon Division (-BB), 1 265 m (4 150 ft.), 13/6/1975, Williams 2006 (NBG, holotype).

*Acmadenia nivea* is recognised as distinct on account of having glabrous lanceolate leaves, snow-white petals closing the throat of the flower, staminodes varying from 0,09 to 0,5 mm long, anthers with minute  $\pm$  sessile apic-

al glands and a 3–4 carpellate ovary. It is nearest to *Acmadenia candida*, a smaller plant, in which however the ovary is reduced to only two carpels.

**33. *Acmadenia candida*** Williams in Jl S. Afr. Bot. **44**(4): 352 (1978). Type: CAPE—3419 (Caledon): in a marsh on level area, top of road from Nuweberg Forest Station, mixed up with low dense Restionaceae, east slopes of Landdrost Kop, Caledon Division (-AA), 1 070 m (3,500–4 000 ft.), 17/3/1968, *Esterhuysen 31946* (BOL, holotype).

*Acmadenia candida* is recognised as distinct on account of being an extremely slender glabrous plant with few branches, with white petals, with reduced staminodes, with anthers minutely stipitate glandular and with a 2-carpellate ovary. It is closest to *A. nivea* which however has staminodes somewhat less reduced and an ovary with 3 or 4 carpels.

#### SPECIES EXCLUDED

1. *Acmadenia apetala* Dümml. in *Fedde Repert.* **11**: 121 (1912).

This is *Diosma apetala* (Dümml.) Williams in Jl S. Afr. Bot. **40**(4): 278 (1974).

2. *Acmadenia assimilis* Sond. in Fl. Cap. **1**: 383 (1860).

This is *Euchaetis laevigata* Turcz. in Bull. Soc. Imp. Nat. Mosc. **31**(1): 438 (1858).

3. *Acmadenia barosmoides* Dümml. in Journ. Bot. **51**: 221 (1913).

This is *Phyllosma barosmoides* (Dümml.) Williams in Jl S. Afr. Bot. **47**(4): 755 (1981).

4. *Acmadenia cassiopoides* Turcz. in Bull. Soc. Imp. Nat. Mosc. **31**(1): 439 (1858).

This is *Macrostylis cassiopoides* (Turcz.) Williams in Jl S. Afr. Bot. **47**(2): 192 (1981).

5. *Acmadenia diosmoides* Schltr. in Bot. Jb. **24**: 439 (1898).

This is *Euchaetis diosmoides* (Schltr.) Williams in Jl S. Afr. Bot. **40**(4): 280 (1974).

6. *Acmadenia harveiana* Schltr. ms. Dümmler in *Fedde Repert.* **11**: 121 (1912) nom. nud.

This *Euchaetis pungens* (Bartl. & Wendl.) Williams in Jl S. Afr. Bot. **40**(4): 279 (1974).

7. *Acmadenia laevigata* Bartl. & Wendl. Diosmeae in Beitr. Bot. **1**: 64 (1824).

This is *Euchaetis meridionalis* Williams in Jl S. Afr. Bot. **44**(4): 329 (1978).



8. *Acmadenia laevigata* E. Mey. ms. in Drège, Zwei. Pflanz. Doc. 122, 161 (1844).

This is *Euchaetis laevigata* Turcz. loc. cit.

9. *Acmadenia macrostylioides* Schltr. ms.

This is *Euchaetis elsiae* Williams in Jl S. Bot. 40(2): 85 (1974).

10. *Acmadenia marlothii* Dümml. in Ann. Bol. Herb. 3(2): 86 (1921).

This is *Agathosma rudolphii* Williams in Jl S. Afr. Bot. 41(4): 239 (1975).

11. *Acmadenia pungens* Bartl. & Wendl. Diosmeae in Beitr. Bot. 1: 64 (1824).

This is *Euchaetis pungens* (Bartl. & Wendl.) Williams in Jl S. Afr. Bot. 40(4): 279 (1974).

12. *Acmadenia rosmarinifolia* Bartl. in Linnaea 17: 335 (1843).

This is *Agathosma rosmarinifolia* (Bartl.) Williams in Jl S. Afr. Bot. 39(2): 179 (1973).

#### PHYTOGEOGRAPHY

The choice in placing a plant into a genus is perhaps rather arbitrary because in nature the occurrence of certain characters appears to be quite at random and many possible permutations of these seem to occur. In the case of the genus *Acmadenia* it seemed more practical to propose six sections rather than to create several more genera. In the definition of these sections certain characters are given more weight than others or one may say loosely that some species look more alike than others. It was interesting to see therefore that, when the distribution of the species in these six sections were mapped separately, a pattern emerged. (Figs 29 to 34).

Starting with *Section 1, Macrostylioides* (Fig. 29) with only one species, standing very much on its own, with pedicellate flowers, bearded petals, flat leaves and long horned fruits and with *Section 2, Peltatiglandula* (Fig. 30) in which there are three species with unusual glandular denticulate leaves and

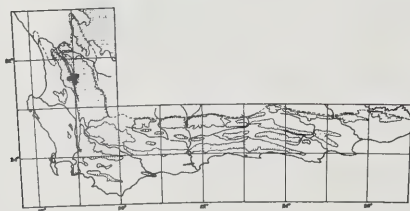


FIG. 29.  
*Section 1, Macrostylioides*: Distribution.

with staminodes and apical anther glands much reduced, these occur in the Clanwilliam Division in the mountains of the South western Cape Province.

In Section 3, *Patentipetalum* (Fig. 31) are grouped seven species in which the flower stands open exposing the anthers and the gynoecium and the anthers all are crowned with a small apical gland. Species in this group are spread over the high mountains of the South western Cape up to Clanwilliam and eastwards along the Swartberg Mountains.

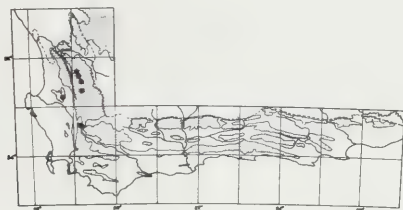


FIG. 30.  
*Section 2, Peltatiglandula: Distribution.*

In these three groups which appear to be from very ancient habitats on isolated mountain areas, we have species that have perhaps not yet developed the closed throat as found in the remaining three sections. These species in Sections 1, 2 and 3 are all very distinct from each other. Many of them are found growing in almost what may be termed "refuge" situations in rock crevices or amongst massive T.M.S. rocks. This may mean that plants in these sections speciated a very long time ago.

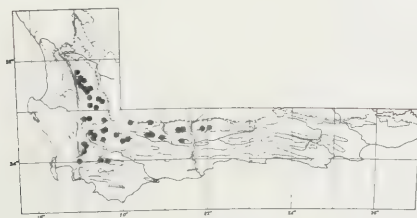


FIG. 31.  
*Section 3, Patentipetalum: Distribution.*

In Section 4, *Glandula* (Fig. 32), containing eleven species, one finds perhaps the most typical species of *Acmadenia* in which the petals are bulged inwards at the throat more or less concealing the gynoecium with

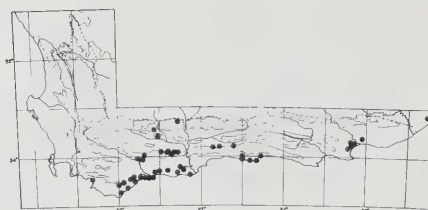


FIG. 32.  
Section 4, *Glandula*: Distribution.

smallish staminodes and with anthers bearing a small apical gland. Species in this section with one or two exceptions, occur at much lower levels including the coast from Walker Bay to near East London in what must be relatively recent habitats.

In Section 5, *Acmadenia* (Fig. 33), containing eight species all with the throat more or less closed, the development of the staminode and of the apical gland or the anther reaches its fullest extent. These species are concentrated in an area between Cape Agulhas and Mossel Bay and inland towards the Swartberg Mountains. Here plants are found on Coastal Limestone, on relic hills of silcrete and on mountain slopes, all habitats that are perhaps relatively not so very ancient. The species in Sections 4 and 5 are almost all rather similar in appearance to each other and include some that are obviously very closely related. This may mean that plants in these sections have speciated relatively recently.

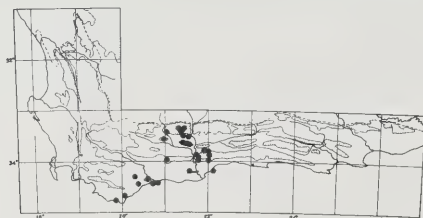


FIG. 33.  
Section 5, *Acmadenia*: Distribution.

Finally in Section 6, *Albiflos* (Fig. 34), containing three species, we see a graduated retreat into reduction. These species are concentrated in the high mountains in the vicinity of the Hottentots Holland in an area well known for its great variety and number of endemics. Here one asks the question, is



FIG. 34.  
Section 6, *Albiflos*: Distribution.

this reduction perhaps the result of pressure from a multitude of other plant species in an area of more than adequate rainfall?

In looking at all six distribution maps an overall picture emerges of growth in numbers of species and of spread from the Clanwilliam area towards the south and towards the east into more recent habitats. The species in the section *Albiflos* being so very different may perhaps represent another line of development and reduction. The fact that no species of *Acmadenia* is to be found on the western coastal plain from False Bay northwards or on the Cape Peninsula probably indicates that these areas were perhaps until recently under the sea or otherwise hostile to plants of this genus.

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## NOTES ON *TULBAGHIA* L.: 4. A SPONTANEOUS HYBRID FROM THE EASTERN CAPE

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### ABSTRACT

A spontaneous hybrid of *Tulbaghia*, found in the Eastern Cape is described and named *Tulbaghia* x *aliceae*. Its putative parents are considered to be *T. violacea* Harv. and *T. verdoornia* Vosa and Burbidge.

### UITTREKSEL

NOTAS OOR *TULBAGHIA* L: 4. 'N SPONTANE KRUISING VANAF DIE OOS-KAAP

'n Spontane kruising van *Tulbaghia* wat in die Oos-Kaap gevind is, is beskryf en *Tulbaghia* x *aliceae* genoem. Die vermeende ouers is *T. violacea* Harv. en *T. verdoornia* Vosa en Burbidge.

Artificial hybridization in *Tulbaghia* has been undertaken by the present author since the early sixties. A first account was published in 1966 (a, b) and the data has been extensively used in the cytotaxonomy of the genus published in 1975.

The aim has been to elucidate the genetic diversity of the species used in the crosses and their relationship. Most species cross readily and the degree of success in hybridization is governed by the affinity of the species involved.

In spite of intensive collecting in recent years, no hybrid *Tulbaghia* has ever been found in the wild, notwithstanding careful search, especially where different species overlap in distribution and flowering time.

In 1977, during a short stay in South Africa, I had occasion to visit Fort Hare University at Alice. There I collected a non-flowering plant of *Tulbaghia*, which was growing on the grass verge in front of a dwelling. Overall the plant resembled *T. violacea* in leaf character and rootstock but I was puzzled by the absence of seed capsules.

Enquiries were made at the time of collection to the owner of the house, adjacent to the grass verge, and it seemed that the plant in question had been collected a few years before "in the mountains" near the town. Unfortunately, shortly afterwards, the district was rescheduled as a black housing area and the grass verge was uprooted and destroyed by the new tenants.

The collected specimen was grown in the cool greenhouses of the Botany

School, Oxford, where it flowered for the first time in 1978 and it proved to be completely sterile.

The flowers are unlike any other species of *Tulbaghia* and intermediate between *T. violacea* and *T. verdoornia*, very similar in fact if not identical with the artificial hybrid described by the present author in 1966 (b): *T. verdoornia* was then considered to be conspecific with *T. dregeana*!

Chromosome analysis (Figs 1, 2 and 3) confirms the morphological diagnosis. The somatic complement of the plant in question contains, in fact, the two haploid karyotypes of the putative parents.

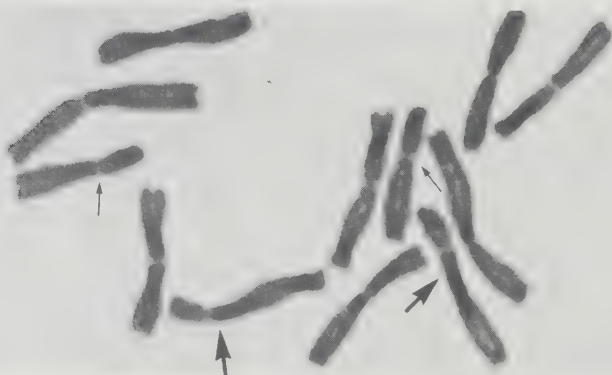


FIG. 1.

The somatic chromosome complement of *Tulbaghia violacea* Harv. The marker chromosomes, two n. 2 and the nucleolar chromosomes n. 6 (type A) are indicated by large and small arrows, respectively.

Three markers are present: the characteristic short short-arm of chromosome 2 of *T. violacea* and the two diverse nucleolar chromosomes of *T. violacea* and *T. verdoornia* which belong to types A and D respectively (see Vosa, 1975, p. 55).

One of the putative parents of the present plant, *T. violacea*, is found wild in the area immediately around Alice, while the known localities of *T. verdoornia* are situated further away to the north east of the town.

*T. verdoornia* is rather inconspicuous and could have been overlooked by collectors and it may well occur sporadically in the Alice area.

I propose to call the hybrid *Tulbaghia x alicae*. Its typification is as follows:

*Tulbaghia x alicae* Vosa (= *T. violacea* Harv. x *T. verdoornia* Vosa and Burbidge).

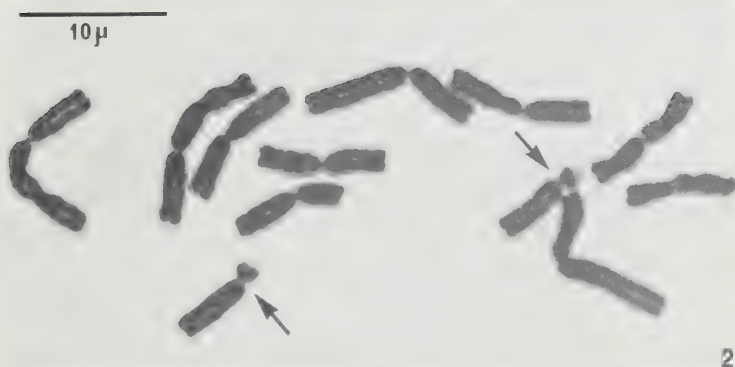


FIG. 2.

The somatic chromosome complement of *Tulbaghia verdoornia* Vosa and Burbidge. The marker chromosomes n. 6 (type D) are indicated by arrows.



FIG. 3.

The somatic chromosomes of *Tulbaghia x alicae* (*T. violacea* Harv. x *T. verdoornia* Vosa and Burbidge). The marker chromosomes, one n. 2 and one nucleolar n. 6 (type A), from *T. violacea*, are indicated by large and small arrows, respectively; the nucleolar chromosome n. 6 (type D) from *T. verdoornia*, is indicated by the double arrow.

*Type*:—3226 (Fort Beaufort): grass verge in the town of Alice (-DD), C. C. Vos. 1511 (OX), from cultivated specimens.

## DIAGNOSIS

Plant media, habitu *Tulbaghia violaceae* Harv. simili, corona carnea, crocea, per partem quintam in lobos 3 acuto-truncatos vel crenatos divisa.

## DESCRIPTION

*Planta* media, habitu *Tulbaghia violaceae* Harv. simili; *bulbo* conico, rhizomati brevi insidenti; foliis 15–35 cm longis, 6–10 mm latis, radicalibus, 6–10, erecto-patentibus, elongatis, apicis obtusis; *scapo* 20–35 cm longo, 5–12 floribus; *bracteis* scariosis; *pedicellis* inaequilongis, filiformibus, 25–35 mm longis; *perigonio* purpureo-viridi, tubo sub-conico elongato, 6–8 mm longo, base rotundata; *segmentis* pallide-roseis, oblongo-lanceolatis, longitudine tubo equilongis; *corona* crocea, carnea, per partem quintam in lobos 3, acuto-truncatos divisa; *stylo* perbrevis, stigmatibus capitatis.

A medium sized plant with the habit of *Tulbaghia violacea* Harv.; *bulb* conical, inserted on the short rhizome; *leaves* 150–350 mm long, 6–10 mm wide, radical, 6–10 in number, elongated with an obtuse apex; *scape* 200–350 mm long, carrying 5–12 flowers; *bracts* scarious; *pedicels* of differing length, thin, 25–35 mm long; *perigonium* purplish-green, with an elongated sub-conic tube, 6–8 mm long with a round base; *segments* pale-rose, oblong-lanceolate, equal in length to the tube; *corona* yellow-orange, fleshy, divided for a fifth of its length into three truncate or crenate lobes; *style* very short, stigma capitate.

## ACKNOWLEDGEMENTS

I wish to thank the C.S.I.R. (South Africa) for financial help; Prof. S. Seagrief, Director, Dept. of Plant Sciences, Rhodes University, Dr. David Mogford of the same Department and Mrs. Estelle Brink of the Botanical Research Unit, Albany Museum, Grahamstown, for valuable logistic help and information.

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## EFFECTS OF SHADING ON NURSERY GROWN ACACIA SEEDLINGS

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### ABSTRACT

This paper describes the effects of shading on four species of phyllodinous Australian acacias (Mimosidae) naturalised in the South Western Cape: *A. cyclops* A. Cunn. ex G. Don., *A. longifolia* (Andr.) Wild., *A. melanoxylon* R. Br. and *A. saligna* (Labill.) Wendl. Seedlings compensated for a 75 % reduction in light intensity by retaining their juvenile leaves longer, and by producing larger, more horizontally orientated phyllodes or leaves. The stems of the shaded plants were etiolated, and their root areas and root and shoot dry masses were less than those of plants grown in full sunlight. *A. melanoxylon* was the most, and *A. cyclops* the least shade tolerant species. Shading, achieved by the use of "smother crops" or by heaps of brushwood, may prove effective in the control of acacia regeneration, provided that at least 90 % light reduction could be obtained.

### UITTREKSEL

#### DIE INVLOED VAN SKADUWEE OP GEKWEKTE ACACIA SAAILINGE

Die invloed van skaduwee op vier Australiese akasias (Mimosidae) met fillodes en wat in die Suidwestelike Kaap genaturaliseer is word beskryf: *A. cyclops* A. Cunn. ex G. Don., *A. longifolia* (Andr.) Willd., *A. melanoxylon* R. Br. en *A. saligna* (Labill.) Wendl. Saailinge het vir 'n 75 % verlaging ligintensiteit gekompenseer deur hulle eerste blare langer te behou en deur groter, meer horisontaal georiënteerde fillodes of blare voort te bring. Die stamme van die plante in skadu was geëtiroleerd en hul wortelareas en wortel en stingel droë massa was minder as die van plante wat in volle son gekweek is. *A. melanoxylon* het die meeste en *A. cyclops* die minste skadu-toleransie getoon. Beskaduwing deur "smoorgewasse" of deur hope kreupelhout mag effektief blyk te wees om die regenerasie van akasia te beheer mits daar ten minste 90 % lig vermindering te weeg gebring kan word.

### INTRODUCTION

Some of the Australian *Acacia* species introduced to South Africa during the mid-nineteenth century have become naturalised, and are now considered to be problem plants on disused land and in the indigenous vegetation of the South Western Cape (Taylor, 1975; Hall & Boucher, 1977). After the removal of unwanted acacia thickets by fire or felling, the regeneration is generally controlled by herbicide treatment, slashing or weeding. An eco-



mical control program less damaging to the remaining indigenous plants and to the environment is needed.

Methods suitable for controlling shrub encroachment in grasslands, such as the use of browsing animals, or annual burns cannot be considered for use in the shrubby Fynbos which grows in shallow soil on steeply sloping ground. In their natural habitats in Australia or in Africa, there is very little acacia seedling regeneration beneath the canopy of mature acacia trees (Howard, 1974; Obeid & Seif el Din, 1970). There is also little or no regeneration under thickets or plantations of acacias growing as exotics (Donald, unpubl.; Milton, unpubl.), and acacia seedlings rarely survive under closed canopies of grasses (Brown & Booysen, 1967) or trees and shrubs (Roux & Middlemiss, 1963; Gilbert, 1959; Howard, 1974; Noble & Slatyer, 1977).

Lack of acacia seedling regeneration under a canopy could be due to either enforced dormancy, or to low seedlings survival rates. The latter is the more likely alternative since acacia seeds can germinate in the dark (Preece, 1971), and numerous seedlings have been seen under the deep shade of acacia thickets during the rainy season, few of which survive.

A number of factors may be responsible for the death of the acacia seedlings growing beneath taller plants: competition for water and nutrients or light, susceptibility to pathogens or inhibition by chemicals released by the roots or litter of dominant plants. The fact that heaps of brushwood control acacia regeneration as effectively as cover provided by living trees (Milton, unpubl.) indicates that the failure of seedlings to survive under a canopy is directly related to shading. This is not unexpected in the genus *Acacia*, where most of the species are heliophilous members of the early stages of succession (Weisser & Marques, 1979; Brown & Booysen, 1967; Noble & Slatyer, 1977; Pedley, 1978).

If shade could be used to control regeneration, it would have the advantage of disturbing the soil and remnant vegetation less than would mechanical methods. Shading has been used to control such weeds as *Stipa trichotoma* Nees and *Baccharis halimifolia* L. (Wells, 1977; Panetta, 1977).

This study is concerned with the effects of shade alone on the growth and morphology of acacia seedlings. In the experimental work predation, competition and allelopathy were eliminated or equalised as far as was possible.

## METHODS

### *Nursery experiments*

Locally collected seed of the four *Acacia* species were pretreated with hot water, germinated in petri dishes, and then planted singly in nursery bags. Clay-loam was the potting medium for *A. longifolia* (Andr.) Willd. and *A. melanoxylon* R.Br., but *A. cyclops* A.Cunn. ex G.Don. and *A. salig-*

na Labill.) Wendl. were planted in Cape Flats sand. These are the substrates normally found in habitats infested by the respective *Acacia* species. Both media had been sieved to facilitate the extraction of the root systems for growth evaluation.

The nursery bags were arranged in two sets on plastic sheets. One set was placed under a frame covered with black nylon shade-cloth which excluded 75 % of the light and reached the ground on all sides. The other set was set out in the open away from the shade of trees or buildings.

### Measurement of parameters

Seedlings were harvested 3, 4, 6, 8, 10 and 15 months after germination.

Root systems were extracted by washing the decanted plant over 1 mm plastic mesh. Root length was estimated using a method adapted from Rowse & Phillips (1974). Washed roots were spread out on a plastic sheet on which had been printed a grid of black lines one or two centimetres apart. The root/grid-line intersections were counted, and an estimate of root length was obtained from equation (1):-

$$L = \frac{1}{2} \pi D/2. N \dots\dots\dots (1)$$

where L is the estimated root length; D is the size of the grid squares and N is the number of root/grid-line intersections. This method gave results which compared favourably with results obtained by measuring each rootlet with dividers and ruler.

The average size of a photosynthetic organ (based on measurements of five mature leaves per plant) was calculated from the product of length, breadth, and a factor 'C' estimated to compensate for its non-rectangular shape. 'C' = 0,5 for the fusiform phyllodes of *A. saligna*, 0,6 for pinnate leaves, and 0,7 for the phyllodes of *A. cyclops*, *A. longifolia* and *A. melanoxylon*.

The total photosynthetic area was calculated by multiplying the mean leaf or phyllode area by the number of these organs on the plant. This statistic probably represents only half the actual photosynthetic area, because the dorsal and ventral surfaces of phyllodes appear to be similar.

In assessing the orientation of a leaf or phyllode, inclination but not rotation, was measured (Figure 1). The angle between the axis of the leaf or phyllode, and the vertical, gave an indication of verticality, 0° being vertical and 90° horizontal. This measurement was independent of stem angle, an important consideration in the case of lateral branches and tilted leader shoots.

After all other parameters had been measured, root and shoot were separated, oven-dried at 100 ° C for 24 hrs, and then weighed.

Fig. 1

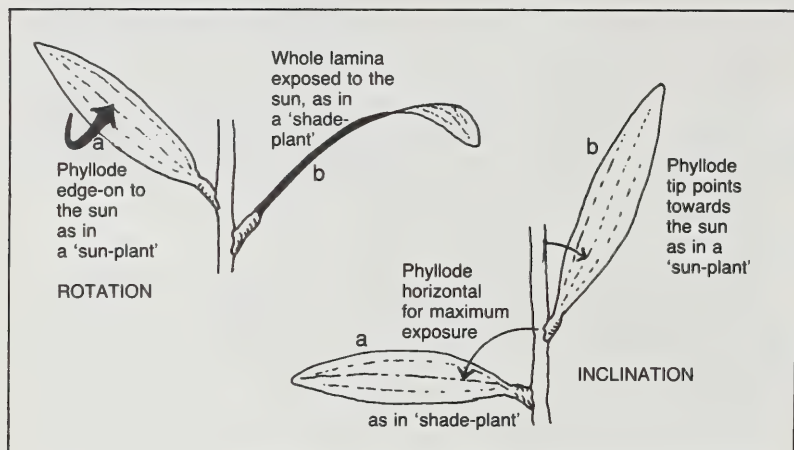


FIG. 1.

Foliage orientation, showing: ROTATION with phyllode (a) edge-on to the sun and (b) with lamina facing the sun, and INCLINATION with phyllode (a) near horizontal and (b) near vertical.

#### Relative growth rate . . . (R.G.R.)

R.G.R. was calculated using an equation (2) from Evans (1972):

$$\text{R.G.R.} = \frac{\log e_1 W - \log e_2 W}{_2T - _1T} \dots\dots\dots (2)$$

where  $_2W$  and  $_1W$  are the dry weights at the beginning and end of the harvesting period  $_1T$  to  $_2T$ , and the units are grams  $\text{g}^{-1}$  month $^{-1}$ .

#### Field studies

The relative light intensity under the shade of an isolated tree and under heaps of brushwood was measured using a photographic light meter (Sekonic Studio). Paired measurements were made a few seconds apart in shade and in the open. Light intensity in shade is expressed as a percentage of that in the open.

The heights of labelled *A. melanoxylon* seedlings growing under a parent tree, and of others in an open site, were measured at monthly intervals over a

period of 18 months. The results are of interest, as the possible occurrence of allelopathy, competition, predation and drought stress could not be controlled in the field.

## RESULTS

### *Growth rates of the four acacia species*

Relative growth rates of self-established seedlings measured in the field during their second year (Table 1) suggest that *A. saligna* grows faster than the other three species. However, both *A. saligna* and *A. longifolia* may be over 2 m tall within 2 years of germination.

The rapid height growth of these acacia seedlings means that they overtop Fynbos species 12–24 months after a fire, and eventually suppress this light-demanding indigenous vegetation (Figure 2). In deep shade (10 % of sunlight) *A. melanoxylon* seedlings remained stunted (Figure 3) and their R.G.R. was only 14 % that of seedlings growing in the open (Table 1).

### *The effects of shading on acacia seedling growth-habit and morphology*

Figures 4 and 5 illustrate the difference between acacia seedlings grown in full sunlight and those grown in one quarter sunlight. Shade-plants (Figure 4) are taller, and have retained their apical dominance for longer than plants grown in the open. The latter often develop prostrate or slanted leader shoots, and have many lateral shoots near the stem base. The stems of the sun-plants are red or yellow when young, rapidly becoming brown and woody with age; those of shade-plants remain green and pliable.

In the open, *A. melanoxylon* develops its first phyllodes at eight months, whereas in the shade it bears only pinnate leaves until it is about one year old. *A. cyclops*, *A. longifolia* and *A. saligna* seedlings develop their first phyllodes at about four months, whether grown in the sun or in the shade, but juvenile pinnate foliage, which has normally been lost by six months, is retained for up to 10 months in the shade.

The foliage of shade-plants is a light grassy green, their laminae thin-textured, broad, and in the case of *A. saligna*, undulating; those of sun-plants are relatively narrow, leathery and dark green, glaucous or red-tinted. The phyllodes and leaves of all species are held almost vertical in sun-plants, but in shade tend to droop or to be held horizontally (Figure 4). Notice that the phyllodes of the sun-plants are seen broad-side-on, while many shade-plant phyllodes are presented edge-on to the camera. Phyllodes can apparently be rotated so as to present only their margins to the sun (sun-plants) or the entire upper surface of the lamina (shade-plants).

Poor root development was a feature of shaded plants of all species and was obvious from the first harvest until the last root harvest at 10 months.

TABLE 1.  
Growth of acacia seedlings in the field during their second year

Species Site	<i>A. cyclops</i> <sup>1</sup> coastal	<i>A. longifolia</i> inland	<i>A. melanoxylon</i> inland	<i>A. melanoxylon</i> inland <sup>2</sup>	<i>A. saligna</i> coastal	<i>A. saligna</i> inland
R.G.R. (g/g/ month) . . . . .	0,284	0,342	0,306	0,043	0,449	0,443
Height incr. (cm/mth) . . . . .	3,6	13,6	7,7	1,7	13,1	14,8
Tot. height at 2 yr (cm) . . . . .	—	213	142	29	207	225

<sup>1</sup> age unknown

<sup>2</sup> deep shade (10 % normal sunlight)



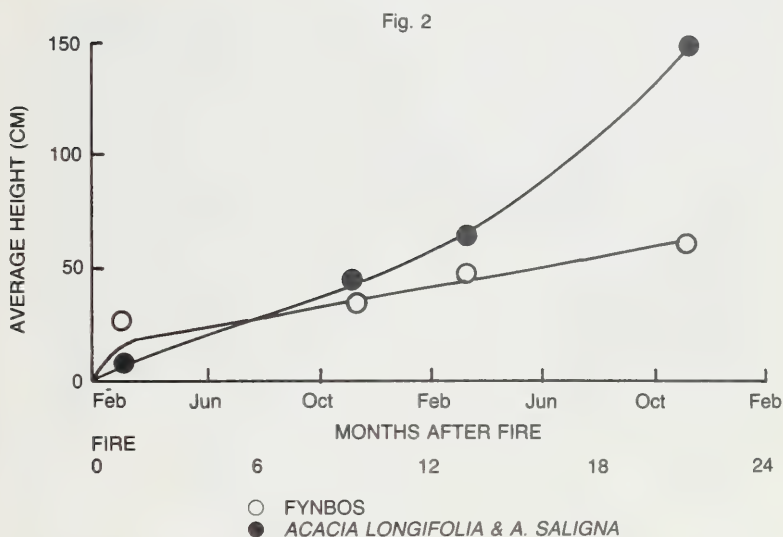


FIG. 2.

Cumulative height growth of *Acacia saligna* and *A. longifolia* seedlings, and Fynbos shrubs after fire. (Data from a single 100 m<sup>2</sup> plot on the burned lower north-facing slopes of the Constantiaberg, Cape Peninsula).

The effects of shading on the root systems of three and four month old seedlings are illustrated in Figure 5; notice too the advanced development of nodules on the sun-plants.

#### *Quantitative assessment of shading effects on acacia seedlings*

Analysis of variance tests were used to compare sun- and shade-plants for all parameters measured at each harvest. The results are summarised in Appendix 1.

**Foliage characters.** Of the foliage parameters tested, pinnate leaf number and foliage orientation were the most light sensitive (i.e. these parameters usually differed significantly between sun- and shade-plants). Shade-plants tended to retain their juvenile pinnate leaves longer. Leaves and pinnules of shade-plants were set further from the vertical (44°) than were those of sun-plants (23°). Differences in the areas and sizes of photosynthetic organs were seldom significant, but there was a tendency for those of shade-plants to be fewer but larger. The total photosynthetic area of *A. melanocylon*

Fig. 3

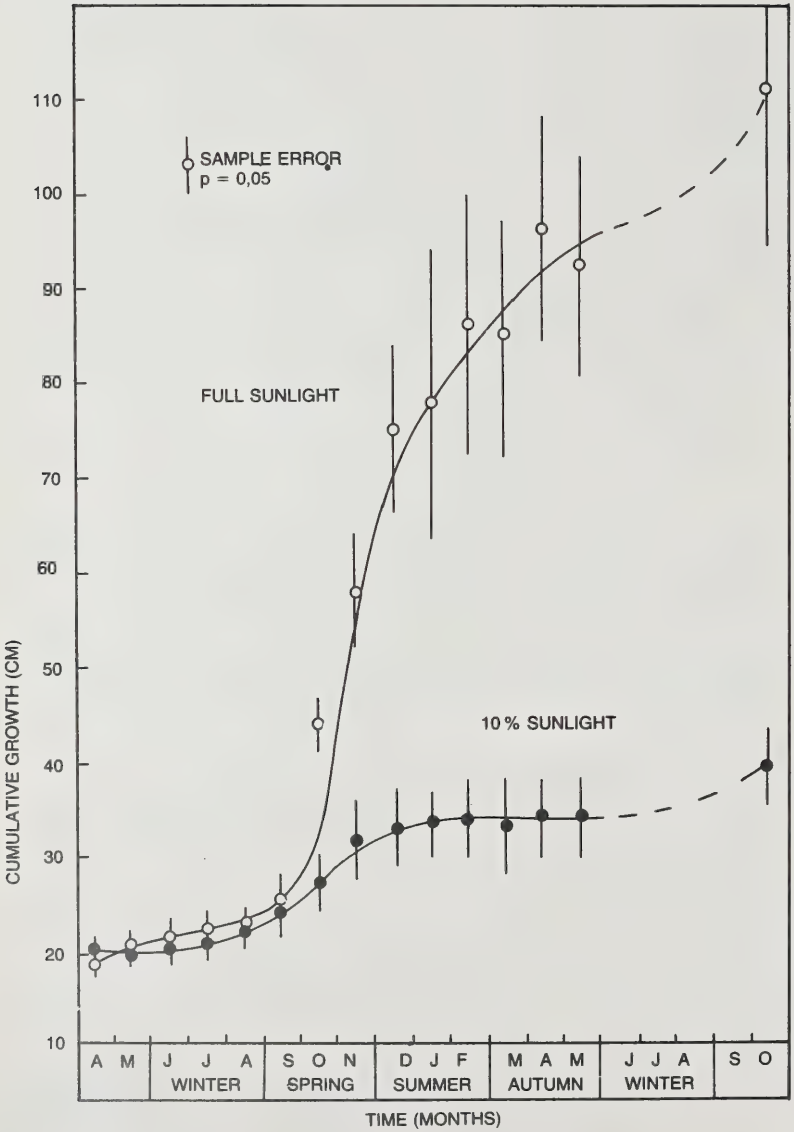


FIG. 3.

Height growth of self-established *A. melanoxylon* seedlings in the field, showing the effect of deep shade on the growth rate of seedlings.

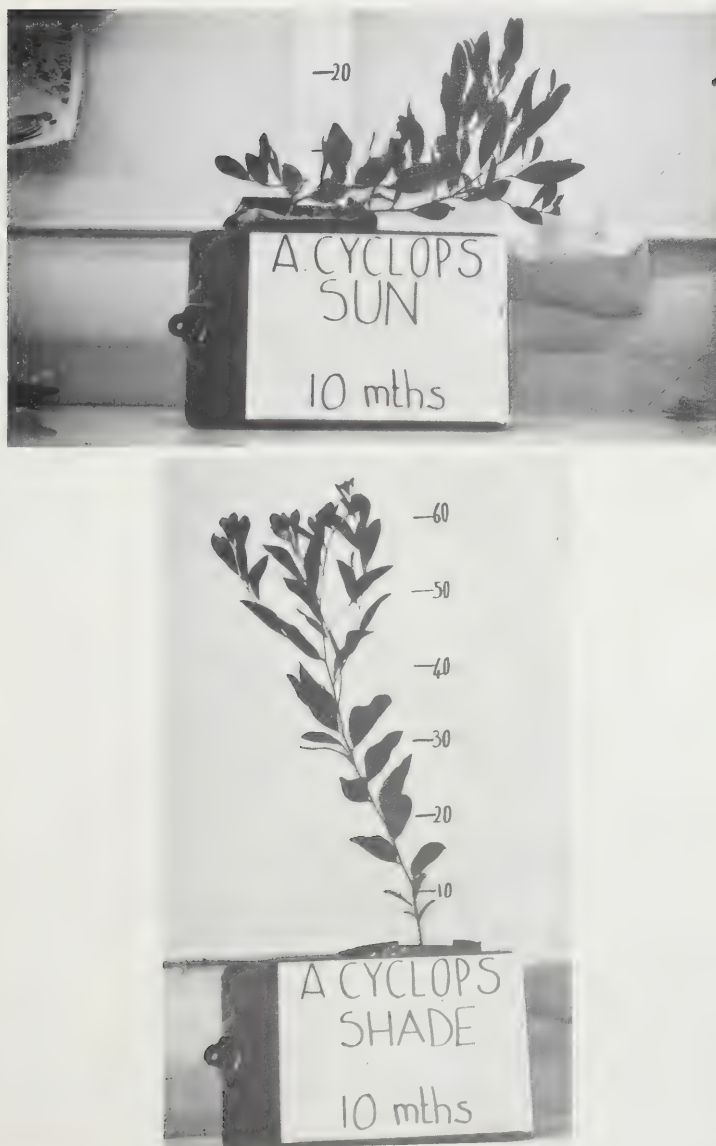


FIG. 4.

Sun- and shade-plants of four *Acacia* species photographed at four months. Note that sun-plants are shorter and more branched. They have more phyllodes, and these are held stiffly, edge-on to the sun in a near vertical position.

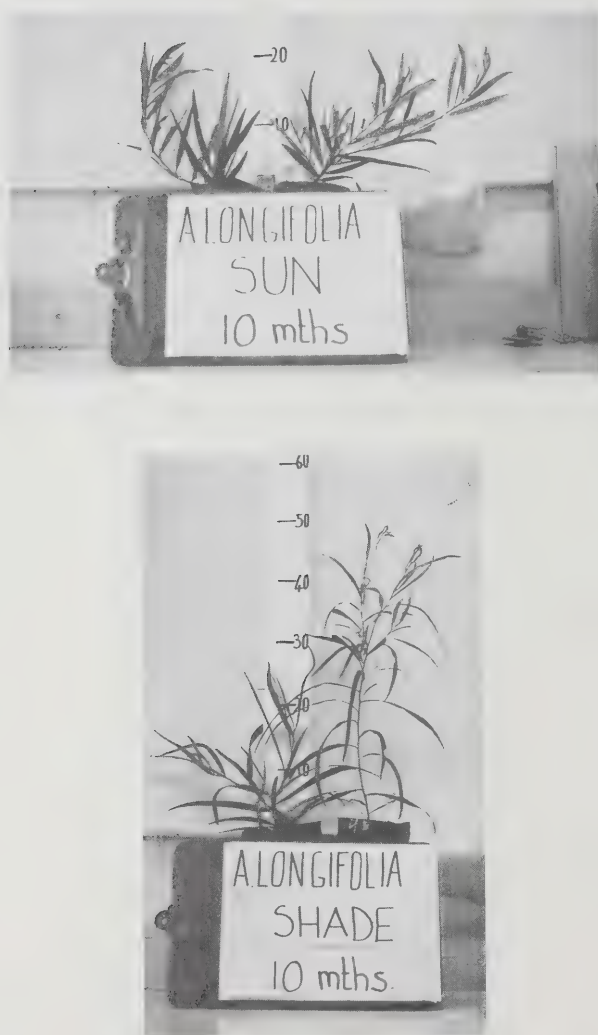


FIG. 4. (Continued)

Sun- and shade-plants of four *Acacia* species photographed at four months. Note that sun-plants are shorter and more branched. They have more phyllodes, and these are held stiffly, edge-on to the sun in a near vertical position.



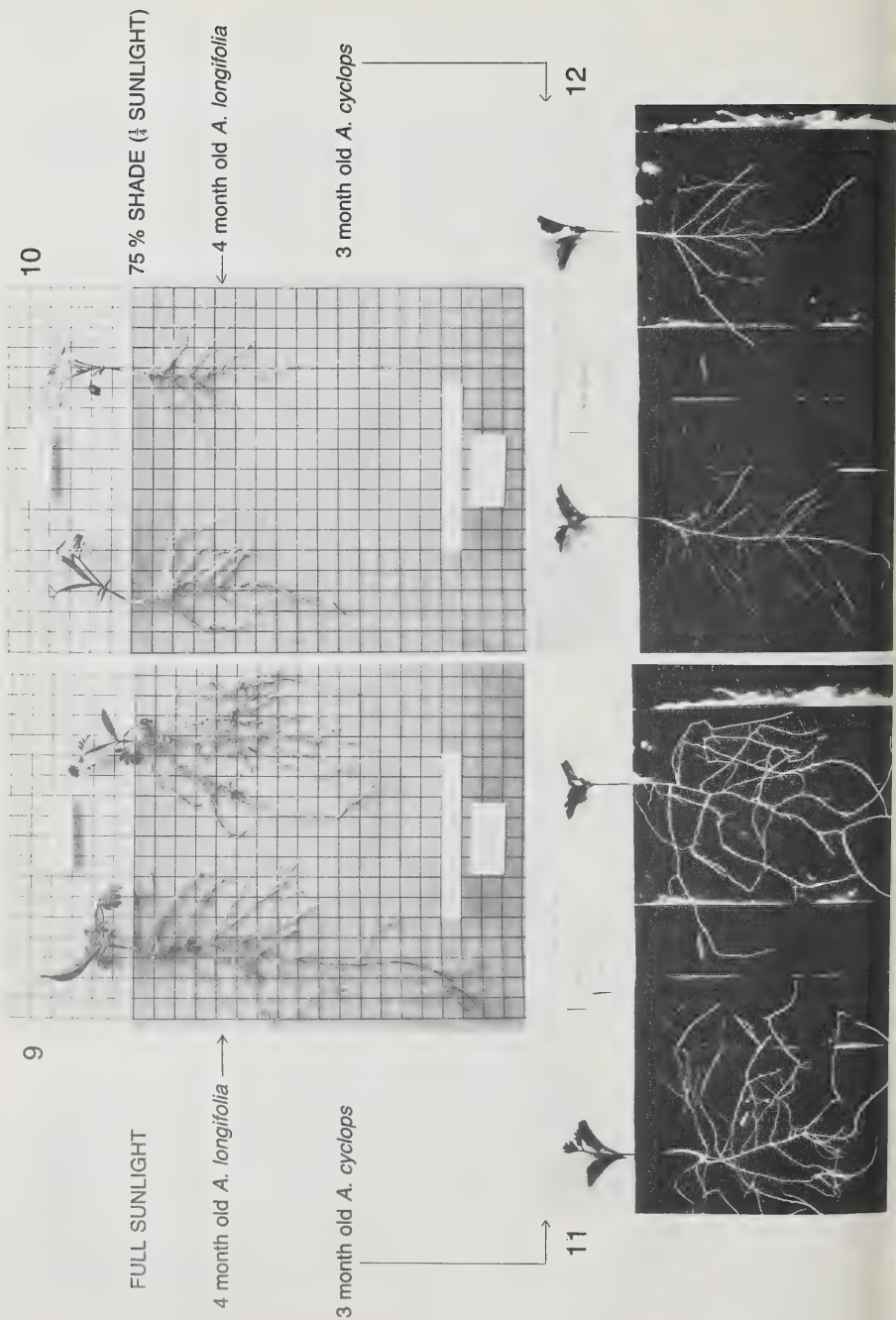
FIG. 4. (Continued)

Sun- and shade-plants of four *Acacia* species photographed at four months. Note that sun-plants are shorter and more branched. They have more phyllodes, and these are held stiffly, edge-on to the sun in a near vertical position.



Fig. 5

The effects of shading on the early development of Acacia seedlings.  
Note the relative scarcity of lateral roots and nodules on shaded plants.



shade-plants was greater, but that of *A. cyclops* less than that of their counterparts growing in the open, suggesting that the latter species was unable to compensate for light reduction by foliage expansion.

**Stem characters.** Shading resulted in etiolation of all four species. This trend was consistent, though, due to undersampling, not highly significant (Appendix 1). Above ground production (shoot dry mass) of *A. melanoxylon* shade-plants did not differ significantly from that of sun-plants, but in other species, notably *A. cyclops*, shoot production was less in the shade. Consistent, if not significant, reduction was recorded in the stem basal circumference and the number of lateral shoots of shade-plants of all species.

**Root characters.** Root production (in terms of dry mass or surface area) was severely curtailed by shading in all species, and appeared to be the most light-sensitive parameter measured. Shade-plants also tended to produce fewer or small nodules, but nodule parameters were highly variable.

**Total dry mass production.** The dry mass of shade-plants was less than that of sun-plants. This trend was highly significant in *A. cyclops* and *A. longifolia*, but not significant in *A. melanoxylon*.

**Shoot/root dry-mass ratio.** This is consistently larger in shade-plants implying that shoot development proceeds at the expense of root development when light is limited. Treatment differences in the shoot/root ratio (Table 2) were more marked in *A. saligna* and *A. melanoxylon*, which maintained good shoot growth in the shade, than in *A. cyclops* and *A. longifolia*, where

TABLE 2.  
Mean shoot/root dry-mass ratios for each harvest.<sup>1</sup>

Age at harvest (months)	<i>A. cyclops</i>		<i>A. longifolia</i>		<i>A. melanoxylon</i>		<i>A. saligna</i>	
	Sun	Shade	Sun	Shade	Sun	Shade	Sun	Shade
3	1,72	2,37	0,87	1,06	0,87	1,57	1,12	1,03
4	2,00	2,61	0,79	1,16	1,03	1,11	1,13	2,78
6	2,19	2,69	1,26	2,50	0,97	1,49	1,44	2,63
8	2,35	4,93	1,86	3,21	1,80	2,62	1,65	2,18
10	2,29	3,78	1,82	2,93	1,04	2,49	1,27	2,67
Significance between months	*	ns	**	**	**	**	ns	ns

<sup>1</sup> Significant differences between treatments are underlined ( $P = 0,05$ ).

Significant differences between months are indicated as follows:

ns = not significant

\* = significant at 0,05 level

\*\* = significant at 0,01 level

shading reduced both shoot and root production. For all four species and under both treatments the shoot/root dry-mass ratio increases as the seedlings grow. Other authors have also found that root growth takes precedence over shoot growth during the early early stages of seedling growth (Panetta, 1977; Withers, 1979), and have suggested that, by stunting the root system, shading causes moisture stress, which leads to the death of seedlings.

*The relationship between total photosynthetic area and total dry mass.*

Shading affects both the photosynthetic area and the total dry mass of acacia seedlings. The increase or decrease in the total photosynthetic area (TPA) or in the total dry mass (TDM) of a shade-plant relative to a sun-plant was calculated as follows:-

$$\Delta X = \frac{{}_2X - {}_1X}{{}_1X} \dots\dots\dots (3)$$

where  $\Delta X$  = difference in TPA or TDM between shade-and sun-plants relative to sun-plant

${}_1X$  = TPA or TDM of a sun-plant

${}_2X$  = TPA or TDM of a shade-plant

The regression of mean  $\Delta$  TDM values on mean  $\Delta$  TPA values, obtained by equation 3, arranged the species linearly in order of their relative 'efficiency' in shade. The linear relationship was not unexpected as photosynthetic area and dry mass are linearly related (Evans, 1972).

In order to illustrate area/mass relationships within as well as between species, all data for each species are plotted, as well as the mathematically fitted curves based on the mean for each species (Figure 6).

*A. melanoxylon*, a sub-climax species, in which shade-plants were found to have a larger total photosynthetic area than sun-plants, suffer minimal fall-off in dry matter production when growing in the shade. The converse is true for *A. cyclops*, a coastal pioneer. TPA was very variable in *A. saligna* and *A. longifolia*, but within these species there was a tendency for larger relative TPA reductions to be correlated with large relative TDM reductions.

Although *A. melanoxylon* was not the most productive species in absolute terms when grown in the shade, its ability to maintain in reduced light at a level similar to that in full light, indicates that it is the most shade tolerant of the four species examined in this study.

Fig. 6

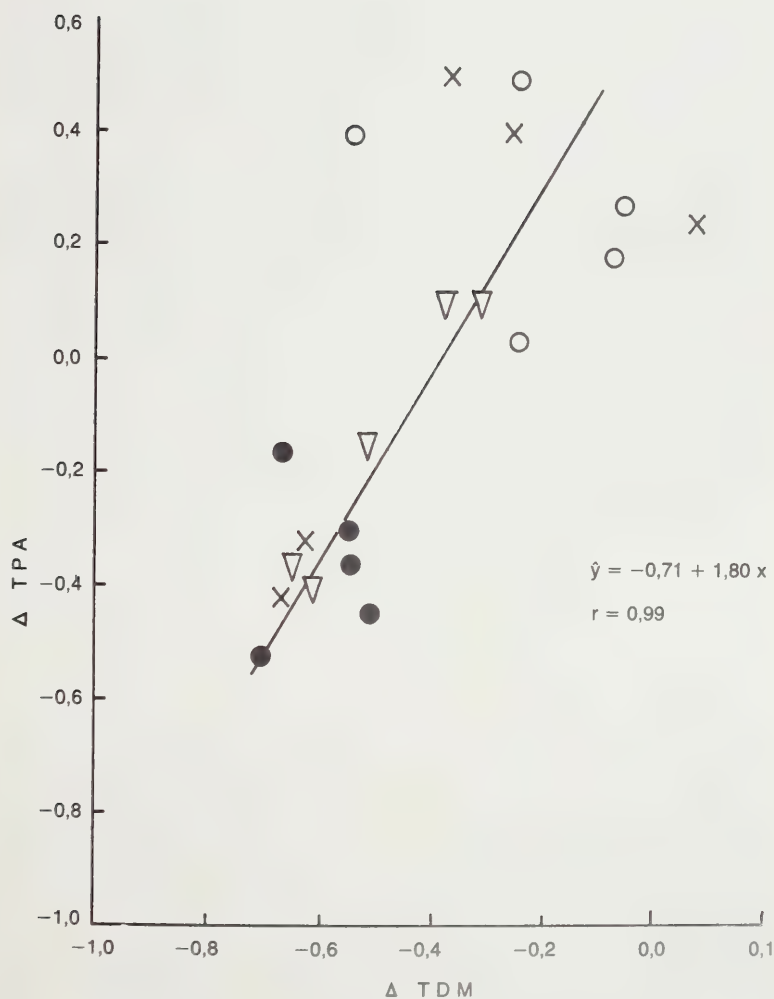


FIG. 6.  
Relative shade 'efficiency' of four species of *Acacia* as illustrated by the relationship between  $\Delta TDM$  and  $\Delta TPA$  values (equation 3). Data are given in full in Appendix 2. Curve is fitted to the mean values for each species.

## DISCUSSION

If one accepts the theory of natural selection, one would expect that the shade tolerance limits of a species would enable it to function most efficiently in its normal habitat. When forced to grow outside its normal range of light intensity a plant can compensate by increasing or decreasing attributes such as the size of its leaves, the amount of chlorophyll that they contain, or the angle at which they intercept the light.

*Acacia* seedlings react to shading in much the same way as seedlings of other kinds of plants (Table 3). In moderate shade, they tended to produce fewer, larger, thinner textured leaves, orientated so as to intercept the maximum amount of light, and plants were generally etiolated and unbranched. The R.G.R. and dry matter production of shaded seedlings was relatively low, and their root systems were reduced and poorly nodulated.

The effects of extreme light reduction are not listed in Table 3. When light is reduced beyond the limits for a particular species, rates of respiration and photosynthesis are reduced so that the compensating morphology can no longer be maintained. Smaller leaves are produced, the growth rate decreases, and the plant remains dwarfed or dies without reproducing itself (Cameron, 1970; Ashton & Frankenberg, 1976; Withers, 1979; Evans, 1972; Panetta, 1977). The degree of shading at which leaves and total leaf areas are smaller rather than larger than those produced by the species in daylight, may indicate the shade tolerance of the species. Reduction in leaf area occurs below 42 % daylight in *Eucalyptus* spp. seedlings (Cameron, 1970; Withers, 1979), below 8 % in the seedlings of *A. pycnantha*, an understorey shrub in *Eucalyptus* woodland (Withers, 1979), and below 2 % for the seedlings of *Acmena smithii* growing beneath the parent canopy in tall closed forest (Ashton & Frankenberg, 1976).

*Acacia cyclops*, a shrub from the dunes of S.W. Australia (Seddon, 1972) was the least shade tolerant of the four species examined in this study. In 25 % daylight it had smaller phyllodes and significantly less total photosynthetic area than it had in the open. It also failed to retain its juvenile leaves in the shade, and its phyllodes were never held at an angle greater than 30° from the vertical. The inability of *A. cyclops* to compensate for reduced light accounts for the extreme differences in root and shoot dry mass between sun- and shade-grown seedlings.

*A. melanoxylon* which was found to be the most shade tolerant of the four *Acacia* species (Figure 6), produced only pinnate leaves in the shade, and these were held at an average angle of 50° from the vertical. This member of the pre-climax sere of the coastal forests of eastern Australia (Farrell & Ashton, 1978) suffers very little loss in dry matter production when grown in 25 % daylight. It requires a minimum of only 20 % daylight for normal



TABLE 3.

Summary of shade-plant characteristics relative to those of sun-plants. The symbols +; =; -; indicate increase, equality or decrease of a parameter in a shade-plant relative to that of a sun-plant. Symbols in parenthesis are based on observations only. Blanks indicate a lack of information.

Species	<i>Acacia cyclops</i>	<i>Acacia longif.</i>	<i>Acacia melanox.</i>	<i>Acacia saligna</i>	<i>Acacia pycnantha</i>	Deciduous hardwoods	<i>Eucalypt ssp.</i>	<i>Impatiens parviflora</i>	<i>Baccharis halimifolia</i>	General
Seral stage	early	mid	late	early	mid	late	late	late	early	-
Height	+	+	+	+	+	+	+	+	+	+
Leaf/phyllode size	+	=	+	=	+	+	+	+	+	+
Juvenile leaf no.	+	+	+	+	+	+	+	+	+	+
Leaf thickness	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Leaf/phyll no.	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
Verticality	-	=	-	=	-	-	-	-	-	-
Total foliage area	-	=	+	=	+	-	=/-	-	-	+
Total chlorophyll	pale	pale	pale	pale	+	-	-/+	-	-	-
Lateral shoot no.	(-)	-	-	(-)	-	-	-	-	-	-
Stem base girth	+	+	+	+	+	-	+	-	-	-
Internode length	-	-	-	(-)	-	-	-	-	-	-
Photosynthetic rate	-	=	=	-	-	-	-	-	-	-
Relative growth rate	-	=	=	-	-	-	-	-	-	-
Shoot dry mass	-	-	=	-	-	-	-	-	-	-
Root dry mass	-	-	=	-	-	-	-	-	-	-
Shoot/root ratio	+	+	+	+	+	-	-	+	+	+
Nodule dry mass	-	-	-	-	=	-	-	-	-	-
Nodule number	-	-	=	-	+	-	-	-	-	-
Moisture content	+	+	+	+	+	-	-	-	-	-
Root surface area	-	-	-	+	-	-	-	-	-	-
Source of data			this study		Withers 1979	Logan 1965	Cameron 1970	Evans 1972	Panetta 1977	Daubenmire 1947

growth (Donald, unpubl.) and can survive in 8 % daylight (Phillips, 1928), although severely stunted in deep shade (Figure 2).

The significance of shade tolerance for management is that, while *A. melanoxylon* seedlings are suppressed in tall climax rain-forest (Howard, 1974; Ashton & Frankenberg, 1976) in Australia and likewise in the indigenous forest of the S. and S.W. Cape (Phillips, 1928; Donald, unpubl.), they can become established in marginal and disturbed forest. Both *A. longifolia* and *A. saligna* showed considerable variation in their reaction to shading (Figure 6). It is possible that these species have a generalist strategy which has enabled them to become naturalised in a wider variety of habitats than *A. cyclops* and *A. melanoxylon*.

#### CONCLUSION AND MANAGEMENT IMPLICATIONS

The seedlings of all the *Acacia* species tested survived for 15 months in 25 % daylight, and by this time had reached a height of 600 mm. A reduction of more than 75 % of incident light would be necessary for the suppression of any of these species.

Field observations suggest that 90 % to 95 % light reduction is adequate for the control of *A. cyclops* and *A. saligna* and probably also *A. longifolia*, since the seedlings of this species also fail to become established in thickets. Deeper shading may be necessary for the control of *A. melanoxylon*.

Shading can be achieved after felling the acacia trees by stacking the brushwood into heaps one or two meters high. Although the open areas between these stacks must be kept weeded of acacia seedlings, this control measure has the advantage of encouraging large populations of rodents which feed on the acacia seed under the brush and in the open. Brush heaps also offer perches for birds: potential vectors of indigenous seed. This method has been used with success on the dunes of the Goukamma Coastal Nature Reserve, S. Cape (Milton, unpubl.) and is recommended for sites subject to erosion where brushwood should be stacked in rows at right angles to the gradient.

To avoid mass germination of acacia seed lying dormant in the soil it is essential to exclude fire for many years, perhaps for over a century, once indigenous vegetation has been re-established. In mountain catchment areas this may conflict with Forestry Department policy, which prescribes burning of the vegetation on a 10 to 15 year rotation (Kruger, 1977).

It may also be possible to provide adequate shade by establishing 'smother crops'. Ideally these should be fast-growing, easily and cheaply established from seed, and unlikely to pose an additional threat to indigenous vegetation. Pioneer grasses such as *Avena fatua* L. and *Ehrharta villosa* Schult. f. grow vigorously on sites recently cleared of acacias. Early seral

Appendix 1  
Data summary for seedling shading experiments.

Parameter	Species	Age mth	Sun-plants			Shade-plants			<sup>1</sup> Signif.
			Mean	(n)	C.V.	Mean	(n)	C.V.	
Shoot length (cm)	<i>A. cyclops</i>	3	3,5	5	35	4,3	5	5	ns
		4	4,6	5	21	5,9	5	9	*
		6	12,2	5	9	17,3	5	17	***
		8	23,5	2	9	43,5	2	10	*
		10	36,5	2	10	67,0	2	46	ns
	<i>A. longi- folia</i>	3	2,3	5	24	2,4	5	28	ns
		4	2,0	5	26	2,8	5	10	**
		6	5,6	5	38	6,9	2	49	ns
		8	24,8	2	14	44,2	2	13	ns
		10	31,0	2	5	36,0	2	64	ns
		15	31,2	5	14	45,5	5	30	ns
	<i>A. melan- oxylon</i>	3	2,1	5	17	2,8	5	17	*
		4	3,5	5	21	3,9	5	25	ns
		6	8,1	5	34	16,1	5	53	ns
		8	37,5	2	9	61,0	2	0	**
		10	39,5	2	23	59,0	2	2	ns
		15	36,5	5	10	54,5	5	27	*
	<i>A. saligna</i>	3	1,2	5	14	1,5	5	10	***
		4	1,1	5	60	3,0	5	32	***
		6	2	5	46	10,9	5	55	ns
		8	28,9	2	8	59,5	2	4	***
		10	36,0	2	43	65,0	2	0	ns
Shoot dry mass (g)	<i>A. cyclops</i>	3	0,04	5	34	0,03	5	15	**
		4	0,12	5	32	0,06	5	17	***
		6	1,05	5	22	0,34	5	26	****
		8	5,38	2	20	2,12	2	4	ns
		10	11,40	2	37	5,95	2	77	ns
		15	15,74	5	18	8,44	5	35	****
Shoot dry mass (g)	<i>A. longi- folia</i>	3	0,03	5	32	0,01	5	46	**
		4	0,04	5	34	0,03	5	31	ns
		6	0,45	5	40	0,20	5	70	ns
		8	3,07	2	4	2,43	2	6	*
		10	4,25	2	15	3,20	2	4	ns
		15	8,10	5	22	7,00	5	63	ns
	<i>A. melan- oxylon</i>	3	0,02	5	10	0,02	5	32	ns
		4	0,05	5	31	0,04	5	30	ns
		6	0,26	5	39	0,29	5	36	ns
		8	4,18	2	14	3,60	2	2	ns
		10	4,65	2	17	2,85	2	37	ns
		15	5,70	5	6	6,10	5	44	ns

<sup>1</sup> Level of significance \* = 0,5; \*\* = 0,25; \*\*\* = 0,1; \*\*\*\* = 0,05

Parameter	Species	Age mth	Sun-plants			Shade-plants			Signifi.
			Mean	(n)	C.V.	Mean	(n)	C.V.	
Mean <sup>2</sup> leaf or phyllode size (cm <sup>2</sup> )	<i>A. saligna</i>	3	0,02	5	68	0,02	5	6	ns
		4	0,11	5	47	0,05	5	32	*
		6	1,17	5	52	0,49	5	59	ns
		8	4,25	2	12	5,13	2	8	ns
		10	10,70	2	74	8,75	2	35	ns
		15	45,73	5	44	20,63	5	33	ns
	<i>A. cyclops</i>	3	1,9	5	52	1,3	5	29	ns
		4	2,1	5	21	2,0	5	36	ns
		6	10,4	5	18	5,2	5	15	****
		8	8,7	2	11	10,3	2	28	ns
		10	17,7	2	10	19,7	2	37	ns
	<i>A. longi- folia</i>	3	0,9	5	43	0,8	5	84	ns
		4	1,0	5	16	1,2	5	28	ns
		6	2,8	5	36	3,3	2	42	ns
		8	5,5	2	19	7,6	2	27	ns
		10	9,6	2	26	12,9	2	1	ns
		15	7,3	5	16	13,4	5	19	***
Mean leaf or phyllode size (cm <sup>2</sup> )	<i>A. melan- oxylon</i>	3	0,4	5	29	0,7	5	39	ms
		4	1,1	5	36	1,6	5	36	ns
		6	2,9	5	28	5,2	5	26	***
		8	3,7	2	40	10,1	2	28	**
		10	7,1	2	12	16,1	2	11	**
		15	6,7	5	16	17,9	5	30	****
	<i>A. saligna</i>	3	0,6	5	23	0,8	5	13	*
		4	1,6	5	24	1,3	5	25	ns
		6	13,5	5	30	5,1	5	42	***
		8	19,6	2	10	17,9	2	2	ns
		10	21,5	2	27	38,4	2	13	ns
	<i>A. cyclops</i>	3	2,8	5	30	2,2	5	21	ns
		4	4,0	5	0	3,0	5	24	**
		6	3,2	5	26	4,6	5	19	*
		8	0,5	2	142	3,5	2	61	ns
		10	0,5	2	142	2,0	2	0	ns
Pinnate leaf number	<i>A. longi- folia</i>	3	3,8	5	12	2,6	5	21	***
		4	4,0	5	18	3,4	5	34	ns
		6	4,4	5	26	4,9	2	0	ns
		8	1,0	2	141	4,5	2	47	ns
		10	0,0	2	0	4,0	2	0	****
		15	0,0	9	0	0,0	5	0	ns

<sup>2</sup>length × breadth × shape factor

Parameter	Species	Age mth	Sun-plants			Shade-plants			Signif.
			Mean	(n)	C.V.	Mean	(n)	C.V.	
	<i>A. melanoxylon</i>	3	4,2	5	20	3,8	5	22	****
		5	6,6	5	8	5,4	5	28	ns
		6	19,8	5	19	12,0	5	16	****
		8	27,5	2	54	20,5	2	3	ns
		10	35,5	2	2	32,5	2	37	ns
		15	9,2	5	81	19,8	5	25	*
Pinnate leaf number	<i>A. saligna</i>	3	5,0	5	14	5,2	5	87	ns
		4	6,4	5	21	6,0	5	29	ns
		6	1,4	5	109	5,0	5	32	***
		8	0,0	2	0	1,5	2	47	ns
		10	0,0	2	0	0,0	2	0	ns
Phyllode number	<i>A. cyclops</i>	3	0,0	5	0	0,0	5	0	ns
		4	0,4	5	138	0,0	5	0	ns
		6	5,8	5	22	4,0	5	31	ns
		8	25,0	2	11	14,5	2	5	*
		10	70,5	2	39	43,0	2	23	ns
	<i>A. longifolia</i>	3	0,0	5	0	0,0	5	0	ns
		4	1,0	5	71	0,4	5	138	ns
		6	13,9	5	29	5,5	2	138	ns
		8	36,0	2	28	25,0	2	62	ns
		10	65,0	2	33	49,0	2	32	ns
	<i>A. melanoxylon</i>	15	84,6	5	20	71,8	5	71	ns
	<i>A. melanoxylon</i>	3	0,0	5	0	0,0	5	0	ns
		4	0,0	5	0	0,0	5	0	ns
		6	0,0	5	0	0,0	5	0	ns
		8	25,5	2	31	0,0	2	0	*
	<i>A. saligna</i>	10	18,0	2	63	0,5	2	142	ns
		15	32,4	5	51	26,8	5	51	ns
	<i>A. saligna</i>	3	0,0	5	0	0,0	5	0	ns
		4	2,2	5	50	1,0	5	71	ns
		6	7,2	5	37	6,0	5	26	ns
		8	13,5	2	26	18,5	2	27	ns
		10	31,0	2	68	26,0	2	44	ns
Total leaf + phyllode number	<i>A. cyclops</i>	3	2,8	5	30	2,2	5	21	ns
		4	4,4	5	13	3,0	5	24	***
		6	9,0	5	22	8,6	5	21	ns
		8	25,5	2	8	18,0	2	16	ns
		10	71,0	2	38	45,0	2	22	ns
	<i>A. longifolia</i>	3	3,8	5	12	2,6	5	21	***
		4	5,0	5	14	3,8	5	34	ns



Parameter	Species	Age mth	Sun-plants			Shade-plants			Signif.
			Mean	(n)	C.V.	Mean	(n)	C.V.	
	<i>A. melanoxylon</i>	6	17,6	5	22	9,5	2	37	*
		8	37,0	2	31	29,5	2	60	ns
		10	65,0	2	33	53,0	2	29	ns
		15	84,6	5	20	71,8	5	71	ns
		3	4,2	5	20	3,8	5	22	ns
		4	6,6	5	8	5,4	5	28	ns
		6	20,0	5	18	12,0	5	17	****
		8	53,0	2	13	20,5	2	4	**
		10	53,5	2	20	33,0	2	39	ns
		15	41,6	5	31	46,6	5	44	ns
	<i>A. saligna</i>	3	5,0	5	14	5,2	5	9	ns
		4	8,6	5	21	7,0	5	17	ns
		6	8,6	5	46	11,0	5	20	ns
		8	13,5	2	26	18,5	2	27	ns
		10	31,0	2	68	26,0	2	44	ns
	<i>A. cyclops</i>	3	11	5	27	6	5	11	ns
		4	18	5	10	11	5	5	**
		6	185	5	9	87	5	8	**
		8	444	2	14	361	2	9	ns
		10	2 559	2	33	1 846	2	40	ns
	<i>A. longifolia</i>	3	7	5	20	4	5	31	ns
		4	11	5	13	8	5	7	ns
		6	101	5	22	68	2	53	ns
		8	384	2	6	408	2	25	ns
		10	1 190	2	5	1 242	2	34	ns
		15	1 248	5	15	2 015	5	39	ns
	<i>A. melanoxylon</i>	3	3	5	16	5	5	17	ns
		4	14	5	16	16	5	8	ns
		6	115	5	12	152	5	18	ns
		8	386	2	19	410	2	18	ns
		10	769	2	22	1 085	2	34	ns
		15	554	5	15	1 812	5	31	ns
	<i>A. saligna</i>	3	6	5	13	8	5	3	*
		4	28	5	20	18	5	15	ns
		6	243	5	28	137	5	24	ns
		8	536	2	25	410	2	18	ns
		10	1 455	2	62	2 053	2	39	ns

<sup>3</sup> Includes both dorsal & ventral surfaces

Parameter	Species	Age mth	Sun-plants Mean (n) C.V.			Shade-plants Mean (n) C.V.			Signif.	
Foliage inclination (degrees from the vertical)	<i>A. cyclops</i>	10	18,0	2	8	29,0	2	5	**	
		15	21,6	5	33	29,0	5	36	ns	
	<i>A. longi- folia</i>	10	27,8	2	22	50,8	2	19	ns	
		15	14,8	5	20	40,6	5	24	***	
	<i>A. melan- oxylon</i>	10	20,3	2	19	58,0	2	24	ns	
		15	16,9	5	20	41,7	5	25	****	
	<i>A. saligna</i>	10	31,5	2	11	49,0	2	9	*	
		15	34,7	3	37	50,7	3	8	ns	
Inter- node length (mm)	<i>A. cyclops</i>	10	18	2	0	21	2	2	ns	
		15	11 13	2 5	13 14	17 16	2 5	3 11	* ns	
	<i>A. melan- oxylon</i>	10	18	2	0	22	2	5	ns	
		15	17	5	13	22	5	10	ns	
	<i>A. saligna</i>	10	19	2	14	36	2	8	*	
	Lateral shoot number	<i>A. cyclops</i>	10	6,5	2	8	6,0	2	0	ns
			15	6,5 6,2	2 5	8 19	6,5 4,4	2 5	8 42	ns ns
<i>A. melan- oxylon</i>		10	17,0	2	6	3,0	2	0	***	
		15	7,8	5	12	7,2	5	23	ns	
<i>A. saligna</i>		10	5,5	2	27	3,5	2	43	ns	
Basal stem circum- ference (mm)		<i>A. longi- folia</i>	15	28	5	7	21	5	9	*
		<i>A. melan- oxylon</i>	15	28	5	5	23	5	9	ns
Moisture content ( % )	Mean of 4 Acacia species									
Foliage Stem Root		10	66,4	8	1	73,9	8	2	*	
		10	55,0	8	4	57,4	8	4	ns	
		10	78,8	8	3	73,9	8	5	ns	

Parameter	Species	Age mth	Sun-plants			Shade-plants			Signif.
			Mean	(n)	C.V.	Mean	(n)	C.V.	
Root surface area (cm <sup>2</sup> )	<i>A. cyclops</i>	3	25	5	30	12	5	23	****
		4	63	5	29	31	5	31	***
		6	224	5	8	99	5	27	****
	<i>A. longi- folia</i>	3	16	5	39	11	5	35	ns
		4	47	5	24	24	5	18	****
		6	145	5	46	62	5	62	ns
	<i>A. melan- oxylon</i>	3	12	5	21	7	5	46	**
		4	32	5	33	20	5	18	*
		6	107	5	29	76	5	33	ns
	<i>A. saligna</i>	3	30	5	18	17	5	23	ns
		4	97	5	13	30	5	62	****
		6	172	5	19	140	5	37	ns
Root dry mass (g)	<i>A. cyclops</i>	3	0,03	5	36	0,01	5	17	***
		4	0,06	5	20	0,03	5	36	****
		6	0,48	5	9	0,13	5	32	****
		8	2,28	2	11	0,51	2	58	**
		10	4,91	2	26	1,50	2	66	ns
	<i>A. longi- folia</i>	3	0,04	5	47	0,01	5	43	**
		4	0,06	5	38	0,02	5	35	**
		6	0,35	5	11	0,11	2	100	****
		8	1,65	2	3	0,83	2	36	***
		10	2,37	2	8	1,11	2	14	**
	<i>A. melan- oxylon</i>	3	0,02	5	33	0,01	5	42	*
		4	0,05	5	28	0,04	5	33	ns
		6	0,26	5	35	0,14	5	71	ns
		8	2,40	2	34	1,38	2	10	ns
		10	4,47	2	8	1,13	2	27	**
Root dry mass (g)	<i>A. saligna</i>	3	0,02	5	20	0,02	5	12	ns
		4	0,10	5	29	0,03	5	64	****
		6	0,57	5	58	0,18	5	44	****
		8	2,70	2	37	2,36	2	8	ns
		10	8,40	2	74	3,24	2	28	ns
Nodule number	<i>A. cyclops</i>	3	2,4	5	112	0,2	5	225	ns
		4	2,0	5	50	1,4	5	81	ns
		6	3,8	5	43	3,4	5	94	ns
		8	5,5	2	90	4,5	2	110	ns
	<i>A. longi- folia</i>	3	7,4	5	55	3,8	5	82	ns
		4	8,6	5	24	4,6	5	45	**

Parameter	Species	Age mth	Sun-plants			Shade-plants			Signif.
			Mean	(n)	C.V.	Mean	(n)	C.V.	
Nodule dry mass (g)	<i>A. melanoxylon</i>	6	12.6	5	78	14.5	2	5	ns
		8	32.5	2	67	45.5	2	36	ns
		3	3.0	5	125	1.2	5	108	ns
		4	7.4	5	31	4.0	5	61	ns
		6	12.2	5	41	21.8	5	66	ns
		8	32.5	2	15	27.5	2	23	ns
	<i>A. saligna</i>	3	1.8	5	114	1.8	5	121	ns
		4	2.0	5	0	1.8	5	47	ns
		6	6.6	5	50	4.6	5	73	ns
		8	25.5	2	97	08.5	2	64	ns
	<i>A. cyclops</i>	8	0.27	2	62	0.06	2	83	ns
		10	0.56	2	11	0.25	2	60	ns
	<i>A. longifolia</i>	8	0.18	2	3	0.08	2	25	ns
		10	0.27	2	13	0.16	2	28	ns
Nodule dry mass (g)	<i>A. melanoxylon</i>	8	0.29	2	24	0.06	2	50	ns
		10	0.32	2	2	0.13	2	15	**
	<i>A. saligna</i>	8	0.22	2	14	0.13	2	23	ns
		10	0.35	2	44	0.24	2	54	ns
Whole plant dry mass (g)	<i>A. cyclops</i>	3	0.08	5	35	0.04	5	5	***
		4	0.18	5	27	0.08	5	23	***
		6	1.53	5	17	0.47	5	6	****
		8	7.66	2	18	2.63	2	15	*
		10	16.31	2	34	7.45	2	75	ns
	<i>A. longifolia</i>	3	0.07	5	39	0.03	5	37	***
		4	0.10	5	34	0.05	5	31	**
		6	0.80	5	26	0.30	2	80	*
		8	4.80	2	2	3.30	2	5	****
		10	6.90	2	7	4.30	2	1	***
	<i>A. melanoxylon</i>	3	0.04	5	29	0.31	5	36	ns
		4	0.09	5	41	0.08	5	32	ns
		6	0.51	5	43	0.49	5	55	ns
		8	6.58	2	21	4.98	2	5	ns
		10	9.12	2	13	3.98	2	34	ns
	<i>A. saligna</i>	3	0.04	5	38	0.03	5	12	ns
		4	0.21	5	39	0.08	5	41	***
		6	2.02	5	37	0.67	5	51	***
		8	6.95	2	22	7.48	2	8	ns
		10	19.10	2	74	11.99	2	33	ns





grasses could be further encouraged by nitrogen fertilization, which does not improve acacia growth (R. Specht, pers. comm.; Schönau, 1971). This method would be more suitable for semi-natural recreation areas than for wilderness.

Partial shading of the semi shade tolerant species, *A. longifolia* and *A. saligna*, should be avoided as this could favour their establishment. The problem of the spread of *A. melanoxylon* into indigenous forest has not been solved, but will probably be reduced by low intensity exploitation of indigenous trees. It is Forestry Department policy to lop selected timber trees in the S. Cape forests before felling them, so as to minimise damage to neighbouring trees (M. Cameron, pers. comm.).

Although the nursery experiment provided information on the relative shade tolerance of the four *Acacia* species tested, clearer results might have been obtained by less frequent measuring of a smaller number of parameters over a larger number of replicates.

The exploitation of shade tolerance has promise as an alternative to chemical control of acacias in the S.W. Cape. Field trials should now be carried out to identify suitable smother crops, and develop ways of using plant and brushwood shade to control acacia regeneration.

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## CHROMOSOME NUMBERS OF SOUTHERN AFRICAN PLANTS: 2\*

BERTIL NORDENSTAM

(Swedish Museum of Natural History, S-10405 Stockholm, Sweden)

### GRAMINEAE

*Enneapogon scoparius* Stapf

2n = 40. Orange Free State:—2926 Bloemfontein, *Hanekom* 844 (S.).

*Panicum natalense* Hochst.

2n = 18. Transvaal: Wakkerstroom, Groothoek, *Bührmann* 50 (S).

*Rhynchelytrum repens* (Willd.) C. E. Hubb.

2n = 36. Seeds from Natal: Madtozi, Umfolozi Game Reserve, *Downing* 582 (S, as *Rh. villosum*), cult. in Horto Bergiano, Stockholm, *Nordenstam* 3971 (S).

### LILIACEAE

*Asparagus laricinus* Burch.

2n = 20. Transvaal: Lichtenburg, *Scheepers* 1505 (S).

*Bulbine brunsvigiifolia* Baker

2n = 14. Vanrhynsdorp: 12 km NE of Bitterfontein, *Nordenstam & Lundgren* 1439 (S).

*Bulbine fallax* v. Poelln.

2n = 14. Vanrhynsdorp: 12 km NE of Bitterfontein, *Nordenstam & Lundgren* 1430 (S).

*Bulbine haworthioides* B. Nord.

2n = 14. Vanrhynsdorp: Moedverloor, N of Holrivier, *Nordenstam & Lundgren* 1584 (S in cult.).

*Bulbine lagopus* (Thunb.) N. E. Br.

2n = 14. Caledon: Palmiet River mouth, *Nordenstam & Lundgren* 2162 (S).

*Bulbine mesembryanthoides* Haw.

2n = 14. Oudtshoorn: Meirings Poort, *Nordenstam* 7135 (S).

*Bulbine praemorsa* (Jacq.) Spr.

2n = 14. Vanrhynsdorp: 10 km NE of Bitterfontein, *Nordenstam & Lundgren* 1828 (S).

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*Bulbine sedifolia* Schltr ex v. Poelln.

$2n = 14$ . Vanrhynsdorp: 12 km NE of Bitterfontein, *Nordenstam & Lundgren 1429* (S).

$2n = 14$ . Vanrhynsdorp: 10 km NE of Bitterfontein, *Nordenstam & Lundgren 1826* (S).

*Bulbine torta* N. E. Br.

$2n = 14$ . Vanrhynsdorp: Top of Van Rhy's Pass, *Nordenstam 2987* (S).

$2n = 14$ . Laingsburg: 5 km E of Matjiesfontein, *Nordenstam & Lundgren 2072* (S).

*Bulbinella cauda-felis* (L.f.) Dur. & Schinz

$2n = 12$ . Clanwilliam: 13 miles S of Clanwilliam, *Nordenstam 2919* (S).

$2n = 12$ . Calvinia: 3 miles S of Nieuwoudtville, *Nordenstam 3026* (S).

$2n = 12$ . Clanwilliam: 2 miles E of Klipfonteinrand, *Nordenstam 3049* (S).

$2n = 12$ . Laingsburg: Elandsfontein, S of Witteberg, *Nordenstam 3233* (S).

*Bulbinella setosa* (Willd.) Dur. & Schinz

$2n = 14$ . Calvinia: Klip Koppies, *Nordenstam 3003* (S).

*Lachenalia pusilla* Jacq. f. (det. W. F. Barker)

$2n = 16$ . Vanrhynsdorp: 42 km on Kliprand road, *Nordenstam & Lundgren 1845* (S).

*Lachenalia viridiflora* Barker

$2n = 14$ . Seeds from Hopefield: Vredenburg, leg. *H. Hall*, cult. in Botanic Garden, Lund, *Nordenstam 3960* (S).

## POLYGONACEAE

*Rumex crispus* L.

$2n = 60$ . Calvinia: Kookfontein River, 2 miles SE of Langfontein, *Nordenstam 3567* (S).

## MESEMBRYANTHEMACEAE

*Dactyloopsis littlewoodii* L. Bol.

$2n = 18$ . Vanrhynsdorp: 10 km NE of Bitterfontein, *Nordenstam 1840* (S in cult.).

## MALVACEAE

*Sida rhombifolia* L.

$2n = 14$ . Natal: Wasbank, *Strey 8471* (S).

## COMPOSITAE

*Felicia amelloides* (L.) Voss

$2n = 18$ . Seeds from Kirstenbosch sub nom. *F. aethiopica*, cult. in Botanic Garden, Lund, *Nordenstam 3958* (S).

*Felicia amoena* (Sch. Bip.) Levyns ssp. *latifolia* Grau (det. J. Grau)  
 $2n = 16$ . Bredasdorp: 1,5 mile W of Potteberg, *Nordenstam 1519* (S).

*Felicia elongata* (Thunb.) O. Hoffm.

$2n = 16$ . Seeds from Kirstenbosch sub nom. *F. tricolor*, cult. in Botanic Garden, Lund, *Nordenstam 3957* (S).

*Helichrysum rosum* (Berg.) Less. (det. O. M. Hilliard)

$2n = 28$ . Seeds from Cradock: Bergkwagga Park, Soetkop, *P. Muller 672* (S), cult. in Horto Bergiano, Stockholm, *Nordenstam 3970* (S).

*Kleinia breviscapa* DC.

$2n = 20$ . Vanrhynsdorp: Moedverloor, N of Holrivier, *Nordenstam & Lundgren 1627* (S).

*Osteospermum karroicum* (Bol.) T. Norl. (det. T. Norlindh)

$2n = 16$ . Namibia, Lüderitz-Süd Distr.: 39 miles S of Aus, *Nordenstam 1076* (S).

*Pentzia grandiflora* (Thunb.) Hutch.

$2n = 16$ . Seeds from Kirstenbosch sub nom. *Maticaria pilulifera*, cult. in Botanic Garden, Lund, *Nordenstam 3959* (S).





## CHROMOSOME STUDIES IN THE SOUTHERN AFRICAN FLORA: 29\*

BERTIL NORDENSTAM

(*Swedish Museum of Natural History, S-10405 Stockholm, Sweden*)

### 29. *TRACHYANDRA BULBINIFOLIA* (Dtr) Oberm.

CHROMOSOME NUMBER:  $2n = 14$  (Figs 1a, b).

ORIGIN OF MATERIAL: (a) Rosh Pinah, Lüderitz-Süd Distr., Namibia, *Nordenstam & Lundgren 458* (S); (b) 13 km S of Rosh Pinah, Lüderitz-Süd Distr., Namibia, *Nordenstam & Lundgren 529* (S).

METHOD OF PREPARATION: Root tip material. Feulgen/Acetic orcein staining.

OBSERVATION: No significant differences were observed in the karyotypes of the two populations. The idiogram is based on four metaphase plates of the collection no. 458 and five of no. 529. The chromosomes vary in length between ca. 2 and 9  $\mu\text{m}$ . This appears to be a first generic record.

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\* Financial support from the Swedish Natural Science Research Council is gratefully acknowledged.

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1a

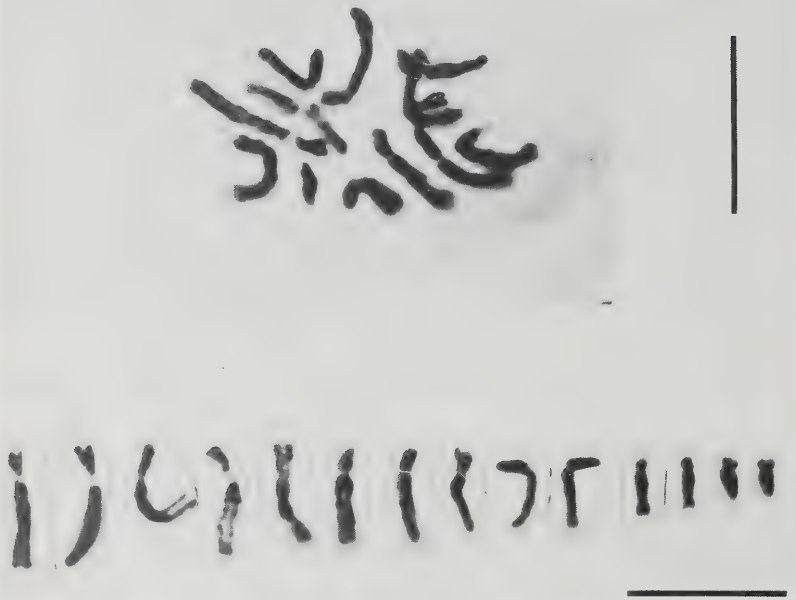


FIG. 1A.

*Trachyandra bulbinifolia*, somatic metaphase (above) and chromosomes from another metaphase plate arranged in descending order of length. The bars represent 10  $\mu\text{m}$ .

1b

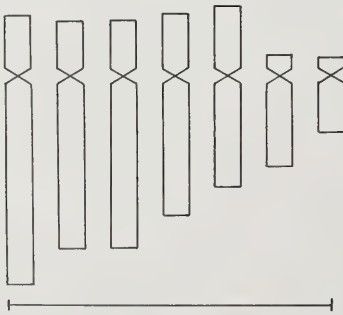


FIG. 1B.

*Trachyandra bulbinifolia*, haploid chromosome complement. Bar represents 10  $\mu\text{m}$ .

**NITELLA EUARTHRA (A.BR.) COMPÈRE (CHAROPHYTA)  
REDISCOVERED IN SOUTH AFRICA**

PIERRE COMPÈRE

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**ABSTRACT**

The endemic South African Characeae *Nitella euarthra*, hitherto known only by the type specimen destroyed in Berlin, is described and illustrated from a specimen recently collected in the same area as the holotype. This specimen is proposed as neotype for this taxon; its taxonomic status is discussed and a new combination is introduced at the rank of species.

**UITTREKSEL**

**NITELLA EUARTHRA (A.BR.) COMPÈRE (CHAROPHYTA) HERONTDEK  
IN SUID-AFRIKA**

Dit tipe-eksemplaar van die endemiese Suid-Afrikaanse Characeae *Nitella euarthra* is in Berlyn vernietig. 'n Beskrywing en illustrasie van 'n eksemplaar vanaf die Kamiesberg, die oorspronklike tipe-lokaliteit word aangebied. Die taksonomiese status van hierdie takson word bespreek, 'n nuwe kombinasie word gemaak en 'n neotipe word aangewys.

In October 1980, C. Evrard, a member of the Belgian Namaqualand-Namib-Expedition sponsored by the "Fonds Leopold III", collected in a pond near Kamiesberg a Characeae that I identified as *Nitella dregeana* f. *euarthra*.

This endemic South African plant was originally described by A. Braun (1868: 878) as *Nitella tricuspis* var. *euarthra*, based on a specimen collected by Drège (no. 2998.6) from a locality "zwischen Pedroskloof und Liliefontein, bei den Kamiesbergen, Nordwestküste des Caplands". Apparently this plant was never collected again and its holotype was destroyed in Berlin. Inquiries in B, BM, BR, HBG and PC failed to locate any duplicate of the type collection. In the latest monograph of the Characeae (Wood & Imahori, 1965) and in the most recent treatment of the family for the *Flora of Southern Africa* (Wood, 1978), this taxon is reduced to the rank of forma, as *Nitella dregeana* f. *euarthra*. In both works the description of this taxon is based only on Braun's original description since neither voucher specimen nor illustration were available. Since the specimen *Evrard 9065*, collected in the same area as the missing holotype, matches well with Braun's original

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description, especially in the moderately stout axes, divergent and recurved dactyls and bigger oospores, it is here formally proposed as neotype for this taxon.

In addition, this specimen shows some features not recorded by Braun (1868): the mature oospore is crowned by flanged prolongations of the spiralled ridges of the outer membrane, a character rarely depicted in *Nitella*, and the whorls often have accessory, shorter and somewhat recurved branchlets, a character shared by *N. hyalina* and other species in the section *Decandollea*. Consequently, this taxon appears as intermediate between the sections *Persoonia* and *Decandollea*; it is here considered as a species belonging to sect. *Persoonia*, because of the reduced dactyls forming tiny terminal coronae, but indicating some transition to sect. *Decandollea* by the presence of accessory branchlets at some whorls. Another South African specimen, Zeyher 4647, "Capland, im Kanal des Zwartkopsrivier, Distr. Uitenhage" was described by A. Braun (1868: 890) under the name *N. hyalina* var. *oligactis* (nom. inval.) as having reduced accessory branchlets; however, examination of a duplicate in PC showed that it is a monoecious plant, with normal dactyls of sect. *Decandollea*, closely related to *N. hyalina*.

***Nitella euarthra* (A.Br.) Compère, comb. et stat. nov. (Fig. 1)**

*Nitella tricuspis* A.Br. var. *euarthra* A.Br. in Monatsber. K. Preuss. Akad. Wiss. Berlin 1867: 878 (1868): holotype: Drège 2998.6 (B †); neotype: Evrard 9065 (BR; duplicates in B, BM, NBG, PRE).

*Nitella dregeana* A.Br. f. *euarthra* (A.Br.) R.D. Wood in Wood & Imahori, Rev. Characeae, vol. I, Monogr.: 701 (1965).

Plant dioecious, 100–150 mm high, with clearly formed heads. Axes moderately stout, 500–1 000  $\mu\text{m}$ . in diameter; internodes 1–2 times longer than the branchlets. Whorls of 6–8 normally developed branchlets, often with some accessory smaller branchlets; sterile branchlets 1–2 furcate, terminated by a corona of (2)–3–(5) tiny, mostly 2-celled dactyls. Fertile branchlets generally condensed into heads; gametangia on separate plants, solitary or geminate at fertile branchlet nodes. Oospores dark brown to almost black, 300–400  $\mu\text{m}$  long, 250–350  $\mu\text{m}$  wide, crowned by the strongly flanged prolongation of the spiralled ridge; membrane coarsely granulose. Antheridia orange, circa 500  $\mu\text{m}$  in diameter.

CAPE PROVINCE—3018 (Kamiesberg): "zwischen Pedrooskloof und Liliefontein, bei den Kamiesbergen, Nordwestküste des Caplands", Drège 2998.6 (B †, holotype); "mare d'eau stagnante, Kamiesberg (= Leliefontein), Namaqualand", Oct. 1980, Evrard 9065 (BR, neotype; B, BM, NBG, PRE).





FIG. 1. *Nitella euarthra*

1. Upper part of female plant; 2. Branchlet of female plant; 3. Oogonium; 4. Oospore with basal claws and apically prolonged ridges; 5. Oospore membrane; 6. Upper part of male plant; 7. Branchlet of male plant; 8. Antheridium; 9. Shield of antheridium; 10. Sterile whorl, with four accessory branchlets; 11. Upper part of sterile branchlets, showing the corona of reduced dactyls.

The new combination *Nitella euarthra* has been previously published by Wood (Wood & Imahori, 1965: 780), in the *Microspecies Appendix* of their *Revision of the Characeae*. This combination is, as are all the new names published in this appendix, clearly invalid under the *International Code of Botanical Nomenclature* (Stafleu *et al.*, 1978) since (1) it lacks the compulsory taxon and direct reference to the basionym (art. 33.2); (2) it is the name of a taxon whose rank is denoted by a misplaced term (microspecies) (art. 33.4 and

specially the Gandoger example); (3) it is not accepted by the author in the original publication (art. 34.1), since Wood consistently uses the combination *N. dregeana* f. *euarthra* in the book and states in the introductory note to the *Microspecies Appendix* that "The microspecies . . . is equivalent to the writer's forms" and that they are provided "in recognition of the possible need or demand for a narrowly defined specific taxon". Thus, the combination proposed by Wood at the microspecies (= form) level is clearly invalid and cannot be used for this taxon at the species rank.

#### ACKNOWLEDGEMENTS

I am greatly indebted to Dr. H. Nowak-Krawietz (B), Mrs. J. A. Moore and Miss Pat Sims (BM), Dr. Ingeborg Friederichsen (HBG) and Dr. Michel Ricard (PC) for their help in trying to locate type material of A. Braun's *Nitella tricuspidis* var. *euarthra* and *N. hyalina* var. *oligactis*.

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## BOOK REVIEW

THE SOIL RESOURCE: ORIGIN AND BEHAVIOUR, by H. Jenny, with pp. xx + 377 and 191 figures. ISBN 3-540-90543-X. Berlin, Heidelberg, New York: Springer-Verlag, 1980. Cloth DM 57, approx. US \$ 33,70.

In 1941, Dr. Hans Jenny published a classic work on soil genesis, entitled *Factors of soil formation*. His latest book is an expanded and revised version of his earlier work, the result of a lifetime of original, stimulating and sometimes controversial endeavour in this field. Processes relevant to soil formation and the interaction between soils and other components of the ecosystem are described and the role of climate, parent material, topography, time and biotic factors in shaping soil properties is emphasized.

The book is divided into two sections, processes of soil genesis and soil and ecosystem sequences. The first section covers soil physics, soil chemistry, plant nutrition, the genesis and transformation of soil constituents, and the development of horizons and profiles. His concepts are sometimes unconventional but valid, for example his classification of the components of soil water potential, and should be viewed as his own understanding and appreciation of soil processes.

The second half of the book covers soil genesis in relation to soil forming factors. Each factor is discussed in turn and examples of soil sequences in which all factors except one remain constant are discussed. The emphasis is on soil genesis, not classification. Various nomenclatures are used, but the U.S. Soil Taxonomy system predominates.

The theme throughout the book is soil in the ecosystem context. A large number of examples drawn from work published during the past century illustrate Jenny's concepts. Most of the examples originate in the United States, but there are many from other countries, including a description of a laterite from Zimbabwe.

The text is informal, descriptive and largely non-mathematical. S I units are not used. A large number of drawings and figures in Jenny's own hand, deliberately retained by the editors, adds a personal touch to the book. Less important sections, detailed descriptions and some examples are set in smaller type and may be omitted during a first reading. Each chapter has a summary.

Although the book is an expansion of Jenny's lecture notes, its broad compass and informal nature renders it most appealing to practising soil scientists and botanists. It is not suitable as an introductory text but should be stimulating to advanced students.

Dr. Jenny has produced a book that is extremely readable and thought-provoking, fine evidence of the range of interests, insight and approach of one of the world's leading soil scientists.

J. L. HUTSON



## TWO NEW SPECIES OF *SERRURIA* SALISB. (PROTEACEAE) FROM THE SOUTH WESTERN CAPE

J. P. ROURKE

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### ABSTRACT

Two new species of *Serruria* with basipetally opening paniculate inflorescences are described; *Serruria confragosa* Rourke from the Cold Bokkeveld and *Serruria williamsii* Rourke from the Riviersonderend mountains, south western Cape.

### UITTREKSEL

TWEE NUWE *SERRURIA* SALISB. (PROTEACEAE) SOORTE VANAF DIE SUIDWESTELIKE-KAAP

Twee nuwe *Serruria*-soorte met basipetaal-opende pluimvormige bloeiwyses word beskryf; *Serruria confragosa* Rourke vanaf die Koue Bokkeveld en *Serruria williamsii* Rourke vanaf die Riviersonderendberge, Suidwestelike-Kaap.

***Serruria confragosa*** Rourke, sp. nov.; frutex 0,7–1,0 m altus, monocaulis, ramis flexuosis, foliis in verticillastros; sed a inflorescentia paniculata sub-corymbosa, 6–14 spicis laxis compositis, spicae basipetae dehiscentes intra inflorescentiam, praecipue distinguitur.

An erect sparsely branched shrub 0,7–1,0 m in height with a single main stem branching into approximately 12–18 erect, simple to only very rarely dichotomous branches. Branches flexuose, glabrous, devoid of leaves for the greater part of their length; leaves usually clustered towards the end of each annual growth flush forming pseudoverticills; reduced to small, acute, glabrous scales on proximal part of each growth flush. Leaves ascending, 30–60 mm long, glabrous, bipinnatifid; segments acicular-terete about 1,5 mm in diam., upper surface minutely canaliculate, apices mucronate. Inflorescence compound; a terminal panicle of 6–14 lax spikes displaying first and second order branching, opening basipetally (centripetally) and usually developing into a loose corymb after anthesis. Peduncle and inflorescence axes 2–3 mm in diam., densely adpressed sericeous; main peduncle 20–50 mm long; axillary axes 10–30 mm long proximally becoming shorter below central terminal spike. Spikes 14–20 flowered, turbinate in bud, elongating after anthesis, bracts and floral bracts ovate, acute to acuminate, densely clasping, adpressed sericeous. Perianth straight 12–14 mm long, tube region glabrous 2–3 mm long; claws densely sericeous, slightly broadened proximally; anthers



elliptic-cymbiform, densely sericeous. *Anthers* sessile. *Style* straight, glabrous, 10–12 mm long. *Pollen presenter* black, clavate, with an annulate thickening at junction with style; stigmatic groove terminal. *Ovary* spherical, 1–2 mm long, distally beset with dense white trichomes. *Hypogynous scales* linear-subulate 1–2 mm long. *Fruit* a slightly compressed cylindric achene 5–6 mm long, truncate and setose at base, becoming densely strigose distally around persistent style base.

*Type:* Skurweberg mountains on summit of Graskop between Boboskloof en Onderboskloof, Cold Bokkeveld (-CC), 10/10/1968, *J. P. Rourke 1136* (NBG, holotype; K, PRE, BOL, MO, STE, S, isotypes).

This species is distinguished by its flexuose branches on which the leaves are clustered towards the end of each growth flush in pseudoverticills, and by its loosely corymbose paniculate inflorescences of between 6 and 14 lax spikes, the spikes opening basipetally (centrifugally) within the whole inflorescence.

*Serruria confragosa* is not obviously allied to any other species in the genus.

The earliest recorded collection of this species was made in 1945 by a Mr. William Ghent somewhere along the Olifants River valley in the Cold Bokkeveld. No further material came to light until 1961, when it was recollected in the same general area by Dr. Ion Williams who kindly showed me specimens growing at Boboskloof. Subsequently I have discovered several populations in the upper Olifants River valley between Onderboskloof and Visgat. At present *S. confragosa* is not known beyond this narrow range—approximately 15 km, in a north-south direction. Most populations are situated on the eastern side of the river in the rough rocky mountainous terrain known as the Skurweberg (Rough Mountain), whence the specific epithet 'confragosa' is derived.

#### SPECIMENS EXAMINED

CAPE PROVINCE—3219 (Wuppertal): Onderboskloof, Cold Bokkeveld (-CC), 15/10/1961, *Williams 42A* (NBG); Skurweberg mountains on summit of Graskop between Boboskloof and Onderboskloof, Cold Bokkeveld, 10/10/1968, *Rourke 1136* (NBG, K, PRE, MO, S, STE, BOL).

—3319 (Worcester): Boboskloof (-AA), 25/10/1967, *Williams 1113* (NBG); Ceres division, Olifants River valley between Ceres district and Citrusdal, 1945, *Wm. Ghent s.n.* (BOL 23211); Between Visgat and Bollemakiesie Kloof, upper Olifants River valley, 2/12/1975, *Rourke 1507* (NBG, K, PRE, MO).

*Serruria williamsii* Rourke, sp. nov.; frutex 0,5–2,0 m altus; foliis 150–200 mm longis, bi-vel-tripinnatisectis, pinnis crassis 2–4 mm latis, et pulvino amplo, in verticillastros dispositis, distinguendus. Differt a *S. elongata* (Berg.) R. Br. propter inflorescentiam paniculatam grandem, 300–550 mm longam.

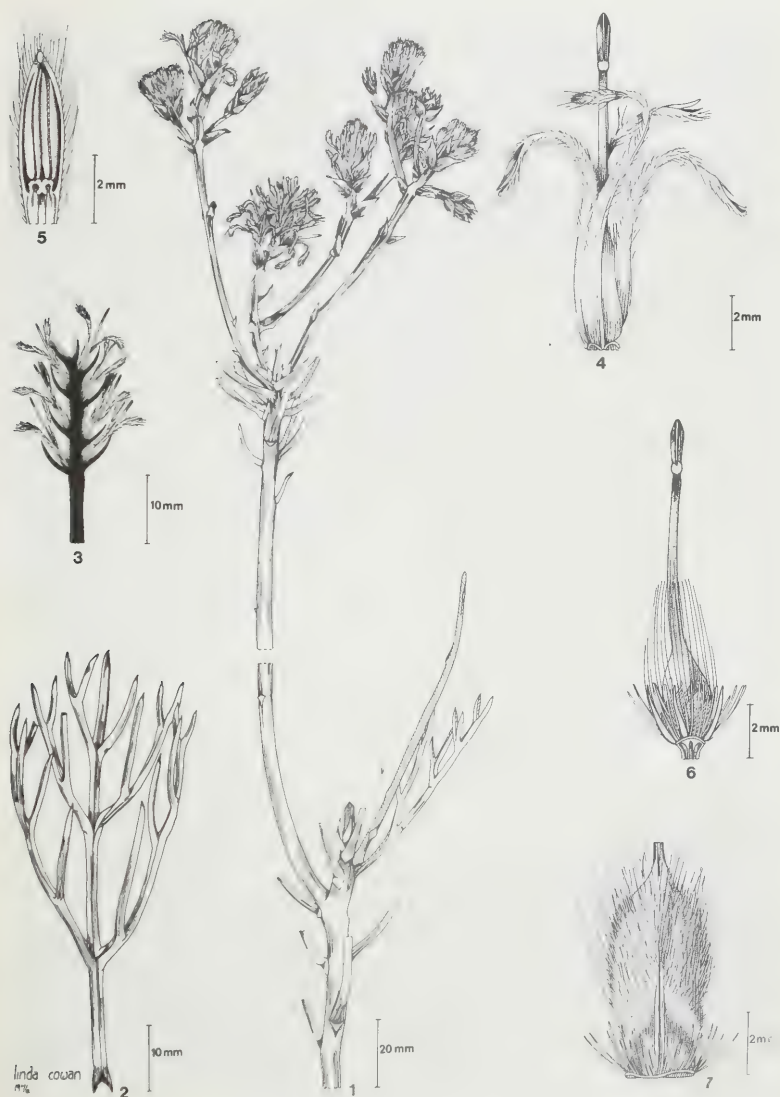


FIG. 1.

*Serruria confragosa*. 1, inflorescence; 2, leaf; 3, longitudinal section through a single spike; 4, flower; 5, perianth limb and anther; 6, gynoecium showing ovary, style, pollen presenter and hypogynous scales; 7, mature fruit. (Drawn from type, *Rolfe 1136* in NBG).



FIG. 2.  
*Serruria confragosa*. Flowering shoots showing clustering of leaves in pseudover-  
tills.

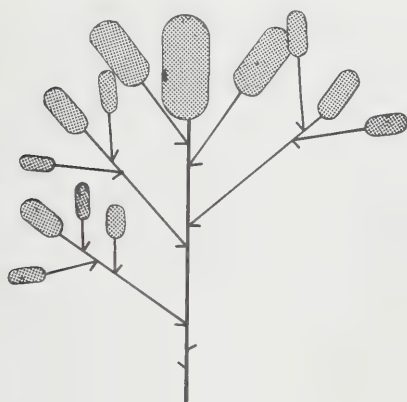


FIG. 3.

*Serruria confragosa*. Diagrammatic representation of inflorescence.

An erect sparsely branched shrub 0.5–2.0 m in height with a single short main trunk to 3 mm in diam.; branching into main axes near base. *Branches* erect, stout, 5–10 mm in diam., glabrous, reddish in live state; each growth flush bare in proximal region where leaves are reduced to scales, fully developed leaves clustered terminally on each growth flush resulting in leaves being arranged up branches in pseudoverticills. *Leaves* 150–220 mm long, glabrous, bipinnatifid to occasionally tripinnatifid, petiolate with a prominent pulvinus; pinnae stout and fleshy, terete, 2–4 mm thick, canaliculate on upper surface, apices sharply cuspidate. *Inflorescence* a massive much branched terminal panicle of capitula, 300–550 mm long; main peduncle stout 3–5 mm in diam., glabrous, reddish brown, 100–300 mm long, usually displaying second order and occasionally third order branching; capitula globose 18–22 mm in diam., opening basipetally (centrifugally) within panicle. *Bracteoles* glabrous, cymbiform-subulate, acute to acuminate, 2–6 mm long. *Involucral bracts* obovate-cymbiform, 2–3 mm long, 2 mm wide, apex mucronate, margins thickly villously fimbriate. *Floral bracts* obovate-cymbiform, keeled, 2 mm long, 1–2 mm wide, apex mucronate, margins thickly villously fimbriate. *Perianth* 10–12 mm long, straight and tubular in bud, separating to near base on opening; tube glabrous, 1 mm long, slightly inflated; claws slender, shortly and densely sericeous; limbs elliptic-acute, short and densely sericeous. *Anthers* sessile. *Style* filiform 10 mm long, glabrous. *Pollen presenter* clavate, slightly annulately thickened at junction with style. *Ovary* 2 mm long, densely lanate with straight pale golden trichomes. *Hypogynous scales* filiform-subulate, 2 mm long. *Fruit* an obovoid to cylindric, sparsely



FIG. 4.

*Serruria williamsii*. Top left, a flowering branch; top right, part of the paniculate inflorescence showing the capitula opening in basipetal (centrifugal) sequences; bottom, type locality on Jonas Kop, with Dr. I. J. M. Williams.



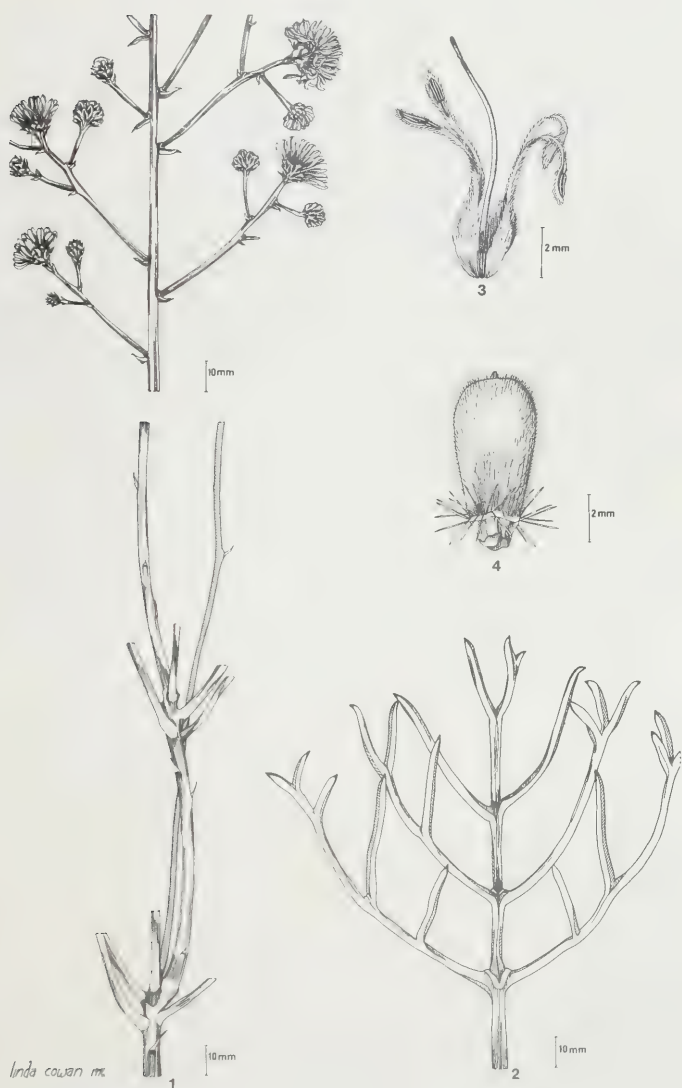


FIG. 5.

*Serruria williamsii*. 1, part of inflorescence; 2, single leaf; 3, flower; 4, mature fruit (Drawn from type, Rourke 1307 in NBG).

sericeous achene, 6 mm long, truncate and pedicellate at base, style base persisting apically.

*Type:* North-West slopes of Jonas Kop near Horlosie Kloof, 19/10/1971, *J. P. Rourke 1307* (NBG, holotype; PRE, K, MO, BOL, STE, S, NSW, L, isotypes).

*Serruria williamsii* falls within the same group of species as *S. elongata* (Berg.) R.Br., *S. leipoldtii* Phillips & Hutchinson and *S. triternata* (Thunb.) R.Br.

It is at once distinguished by its terminal, 300–550 mm long, much branched paniculate inflorescence of globose capitula, the capitula opening on the panicle in basipetal (centrifugal) succession. The massive bipinnate to occasionally tripinnately compound leaves, 150–200 mm long, are clustered terminally on each growth flush, but are elsewhere reduced to scales, thereby giving the impression of being arranged in pseudoverticills. Their stout fleshy pinnae, 2–4 mm wide, are thicker than in any other *Serruria*.

W. J. Burchell made the earliest recorded collection of this magnificent species on the 27th February 1815. While making a halt at Genadendal on his return journey to Cape Town, Burchell ascended the Baviaanskloof mountains to the north of the village. There he collected a sterile specimen on the northern slopes of the present-day Jonas Kop. It was not collected again until May 1968, when Dr. Ion Williams rediscovered a large population on the middle north slopes of Jonas Kop—probably within a kilometre or two of the site where Burchell's collection was made.

Thus far, *Serruria williamsii* is only known from the northern slopes of the Bosjeveld mountains. Scattered populations occur between Horlosie Kloof on Jonas Kop, in the west, and the north slopes of Kanon Kop, above the Poesjenels River valley, in the east, a distance of approximately ten km. Most populations are found as dense local stands at about the 1 000 m contour on rather dry Table Mountain Sandstone slopes in sparse restio veld with *Protea laurifolia*, *P. subulifolia* and *Leucadendron nervosum* as the most prominent associated shrubs.

#### SPECIMENS EXAMINED

CAPE PROVINCE—3319 (Worcester): mountains of Baviaanskloof near Genadendal (-CD), 27/2/1815, *Burchell 7831* (K); Worcester, north facing slopes of Jonas Kop, 23/5/1968, *Williams 1194* (NBG, K); north-west slopes of Jonas Kop near Horlosie Kloof, 19/19/1971, *Rourke 1307* (NBG, PRE, K, MO, BOL, STE, S, NSW, L); on the path from Genadendal to Agterklip Hoogte valley (Poesjenelsrivier), approached from farm "Good Hope" (-DC), Feb., *G.P.K. Kirsten 527* (NBG).

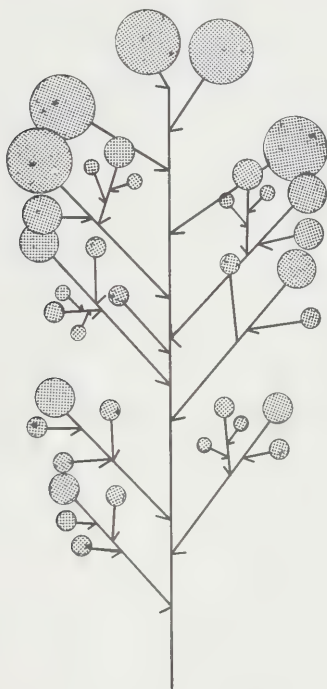


FIG. 6.  
*Serruria williamsii*. Diagrammatic representation of inflorescence.



## THE DIATOMS OF THE JUKSKEI-CROCODILE RIVER SYSTEM (TRANSCAAL, REPUBLIC OF SOUTH AFRICA): A PRELIMINARY CHECK-LIST

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### ABSTRACT

During the years 1972 to 1975 samples of benthic algae were collected from 22 selected river stations in the Jukskei-Crocodile River system. Some 250 diatom taxa were identified from these samples.

### UITTREKSEL

DIE DIATOME VAN DIE JUKSKEI-KROKODIL RIVIERSTISTEEM (TRANSCAAL, REPUBLIEK VAN SUID-AFRIKA). 'N VOORLOPIGE KONTROLE-LYS

Vanaf 1972 tot 1975 is monsters van bentiese alge by 22 uitgesoekte plekke in die Jukskei-Krokodilriviersisteem geneem. Sowat 250 diatoomtaksa is in die monsters uitgeken.

### INTRODUCTION

In order to preserve our South African environment and to reduce secondary pollution, eutrophication of the aquatic environment is receiving increased attention. Diatom species or differentiating groups of diatom species have been successfully used as an index of the quality of running waters (Lange-Bertalot, 1978a; 1979a; 1979b; Schoeman, 1976; 1979). However, the successful determination of water quality using diatoms as indicators is primarily dependent on the correct identification of the diatom taxa. For this reason it is considered appropriate to present this list as a summary of diatom taxa encountered in the running waters of the Jukskei-Crocodile River system. This important river system is subject to enrichment from various sources, and others working on this river system may benefit by having some reference to the extent of the diatom flora.

### DESCRIPTION OF THE STUDY AREA

The Jukskei-Crocodile River system in the Transvaal embraces an area between Johannesburg on the Witwatersrand in the south and the Hartbeespoort Dam below the Magaliesberg Mountains in the north (Fig. 1). The southern catchment area is densely populated and heavily industrialised



whereas the northern part consists mainly of agricultural areas. The geology and climate of the area have been described by Allanson (1961). The Modderfontein Stream and Jukskei River receive effluents from various sources, both domestic and industrial. The upper Crocodile River, prior to its confluence with the Jukskei River, drains a predominantly agricultural area and accordingly contains water of a higher quality.

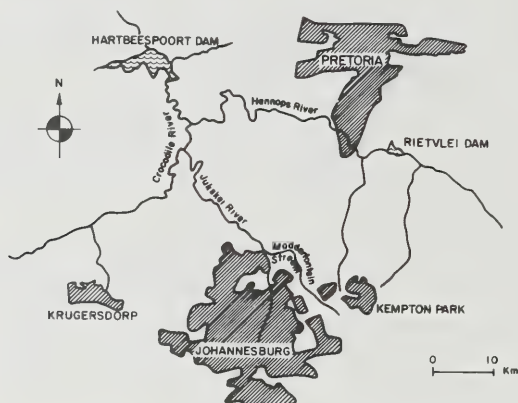


FIG. 1.  
Location of the Jukskei-Crocodile River catchment area.

## MATERIAL AND METHODS

### *Sampling Stations*

Descriptions of the various sampling stations (Fig. 2) in the Jukskei-Crocodile River system are given below (Table 1). Samples were collected monthly at the various stations during the following periods:

Period	Station
March 1972—Feb. 1975	1, 2, 3, 4, 5, 6, 10, 13
March 1972—Feb. 1973	2A
April 1972—Feb. 1975	8, 9, 14
April 1972—July 1972	11
May 1972—Feb. 1975	7, 7A, 12
May 1972—Feb. 1973	11A
Aug. 1972—Feb. 1975	11B
Sept. 1972—March 1973	13A
April 1973—Feb. 1974	6B
May 1973—Feb. 1974	6A
Aug. 1973—Jan. 1975	1A



FIG. 2.  
Sampling stations on the Jukskei-Crocodile River system.

### *Diatom analyses*

Samples of benthic algae were only collected in running water (stones in current, weir overflow, etc.) and preserved with 4% v/v formalin. The diatoms in these samples were acid cleaned and mounted in Naphrax (Welsh, 1964; Cholnoky, 1968a) for microscopical examination.

TABLE 1.

Sites of the sampling stations on the main stream of the Jukskei-Crocodile River system and its tributaries

Station number	River on which station is situated	Site of station
1A	Modderfontein Stream	Above outflow from Kelvin Power Station in Edenvale.
1	Modderfontein Stream	Below outflow from Kelvin Power Station.
2	Modderfontein Stream	Below maturation dams at AECI Limited.
2A	Modderfontein Stream	Above Jukskei confluence.
3	Jukskei	Immediately above Modderfontein Stream confluence in Buccleugh.
4	Jukskei	A hundred yards downstream of station 3 below Modderfontein Stream confluence.
5	Jukskei	Weir opposite Kyalami Ranch, Kyalami on the old Johannesburg-Pretoria road.
6	Jukskei	Weir A <sub>2</sub> M <sub>42</sub> * below Leeukop Prison, Witkoppen after the confluence with the Braamfontein and Sandfontein Streams.
6A	Braamfontein Stream	On the Witkoppen road above its confluence with the Sandfontein Stream.
6B	Sandfontein Stream	On the Witkoppen road above its confluence with the Braamfontein Stream.
7	Jukskei	Below the outfall stream from Northern Sewage Works maturation ponds.
7A	Northern Sewage Works Stream	On the outfall stream below the maturation ponds.
8	Klein Jukskei	At the road bridge on the road between Broederstroom and Four Ways approximately 3 km from the confluence with the Jukskei.
9	Jukskei	Below the Klein Jukskei confluence at Woodmead school.
10	Jukskei	Weir A <sub>2</sub> M <sub>44</sub> * below station 7.
11	Crocodile	On Johannesburg-Broederstroom road.
11A	Crocodile	At Muldersdrift-Krugersdorp-Pretoria crossroads.
11B	Crocodile	Approximately 3 km above Jukskei confluence and about 50 metres above Weir A <sub>2</sub> M <sub>45</sub> *.
12	Crocodile	Between Jukskei confluence and Hennops confluence.
13	Hennops	Above (100 m) confluence with the Crocodile.
13A	Hennops	At Hennops Pride on Hartbeespoort Dam-Johannesburg road.
14	Crocodile	Immediately below Hennops confluence.

\*Numbers of Department of Water Affairs measuring weirs.

## OBSERVATIONS

An alphabetical list of the diatoms identified is given below. The references following each of the listed taxa are those used for their identification. An asterisk indicates that no distinction was made between the forms and/or varieties of that particular species. Illustrations and notes on the taxonomy and occurrence of the recorded taxa, as well as the relationship between the diatom associations and the water quality, will be presented elsewhere.

- Achnanthes exigua* Grunow\* (Schoeman and Archibald, 1977b, No. 3)  
*A. hungarica* (Grunow) Grunow (Hustedt, 1931–59: 383, f. 829)  
*A. lanceolata* (Brébisson) Grunow\* (Hustedt, 1931–59: 408, f. 863)  
*A. linearis* (W. Smith) Grunow (Hustedt, 1931–59: 378, f. 821)  
*A. minutissima* Kützing\* (Hustedt, 1931–59: 376 f. 820)  
*Amphipleura pellucida* (Kützing) Kützing (Hustedt, 1931–59: 724, f. 1095)  
*Amphora coffeaeformis* (Agardh) Kützing (Hustedt, 1930: 345, f. 634; Patrick and Reimer, 1975: 78, pl. 14, f. 11, 12)  
*A. normanii* Rabenhorst (Schoeman and Archibald, 1978, No. 4)  
*A. ovalis* (Kützing) Kützing (Patrick and Reimer, 1975: 68, pl. 13, f. 1, 2)  
*A. ovalis* var. *libyca* (Ehrenberg) Cleve (Patrick and Reimer, 1975: 69, pl. 13, f. 3–6 as *A. ovalis* var. *affinis* (Kützing) Van Heurck and *A. ovalis* var. *pediculus* (Kützing) Van Heurck  
*A. pediculus* (Kützing) Grunow (Schoeman and Archibald, 1978, No. 4)  
*A. submontana* Hustedt (1949a: 112, pl. 11, f. 4)  
*A. tenerrima* Aleem & Hustedt (1951: 16, f. 3)  
*A. veneta* Kützing (Schoeman and Archibald, 1978, No. 4; 1979, No. 5)  
*A. veneta* var. *capitata* Haworth (Schoeman and Archibald, 1978, No. 4)  
*A. sp. [affin. cymbamphora]* Cholnoky, 1960a: 22, f. 54; 1968b: 18, f. 17]  
*Anomoeoneis exilis* (Kützing) Cleve (Hustedt, 1931–59: 751, f. 1114a–c)  
*Caloneis bacillum* (Grunow) Cleve (Hustedt, 1930: 236, f. 360)  
*Caloneis clevei* (Lagerstedt) Cleve (Hustedt, 1930: 236, f. 359; cf. Schoeman and Ashton, 1981)  
*C. hyalina* Hustedt (1937–38: 281, pl. 15, f. 8–10)  
*C. schumaniana* (Grunow) Cleve\* (Hustedt, 1930: 239, f. 369, 370)  
*C. ventricosa* (Ehrenberg) Meister\* (Patrick and Reimer, 1966: 583, pl. 54, f. 3; Hustedt, 1930: 236, f. 362 as *C. silica* (Ehrenberg) Cleve)  
*Cocconeis pediculus* Ehrenberg (Hustedt, 1931–59: 350, f. 804; Patrick and Reimer, 1966: 240, pl. 15, f. 3, 4)  
*C. placentula* Ehrenberg (Hustedt, 1931–59: 347, f. 802a, b; Patrick and Reimer, 1966: 240, pl. 15, f. 7)  
*C. placentula* var. *euglypta* (Ehrenberg) Cleve (Hustedt, 1931–59: 349, f. 802c; Patrick and Reimer, 1966: 241, pl. 15, f. 8)  
*Cyclotella comta* (Ehrenberg) Kützing (Hustedt, 1927–30: 354, f. 183)  
*C. kuetzingiana* Thwaites (Hustedt, 1927–30: 338, f. 171)  
*C. meneghiniana* Kützing (Schoeman and Archibald, 1980, No. 6)  
*C. pseudostelligera* Hustedt (1939: 581, f. 1, 2; Belcher, Swale and Heron, 1966; Genkal, 1977)  
*C. stelligera* (Cleve & Grunow) Van Heurck (Hustedt, 1927–30: 339, f. 172)  
*Cymatopleura librile* (Ehrenberg) Pantocsek (Schoeman and Archibald, 1980, No. 6)  
*Cymbella amphicephala* Naegeli ex Kützing (Patrick and Reimer, 1975: 33, pl. 4, f. 11)  
*C. aspera* (Ehrenberg) H. Peragallo (Hustedt, 1930: 365, f. 680; Patrick and Reimer, 1975: 53, pl. 10, f. 2)

- Cymbella aspera* var. *bengalensis* (Grunow in Schmidt *et al.*, 1874–1959, pl. 9, f. 12) Cleve (1894: 176). Also cf. Hustedt in Schmidt *et al.*, 1874–1959, pl. 375, f. 2, 3, 6
- C. cistula* (Ehrenberg in Hemprich & Ehrenberg) Kirchner (Patrick and Reimer, 1975: 62, pl. 11, f. 3, 4; Hustedt, 1930: 363, f. 676a)
- C. cymbiformis* Agardh (Patrick and Reimer, 1975: 54, pl. 10, f. 3, 4)
- C. ehrenbergii* Kützing (Hustedt, 1930: 356, f. 656) = *C. inaequalis* (Ehrenberg) Rabenhorst (Patrick and Reimer, 1975: 36, pl. 5, f. 3)
- C. kappii* Cholnoky (1953: 142, f. 12–14 as *C. turgidula* Grunow var. *kappii* Cholnoky, 1956: 61, f. 17–20)
- C. kolbei* Hustedt (1949b: 46, pl. 1, f. 20–26)
- C. leptoceros* (Ehrenberg) Grunow (Hustedt, 1930: 353, f. 645)
- C. microcephala* Grunow (Hustedt, 1930: 351, f. 637; Patrick and Reimer, 1975: 33, pl. 4, f. 12, 13)
- C. minuta* Hilse ex Rabenhorst (see *C. ventricosa*)
- C. ?muelleri* Hustedt (1937–38: 425; Patrick and Reimer, 1975: 43, pl. 7, f. 1, 2)
- C. naviculiformis* Auerswald (Hustedt, 1930: 356, f. 653; Patrick and Reimer, 1975: 31, pl. 4, f. 9)
- C. perpusilla* A. Cleve (Cleve-Euler, 1955: 155, f. 1232a–c; Hustedt, 1930: 361, f. 666; Schoeman, 1973: 62, pl. 1, f. 29)
- C. sinuata* Gregory (Schoeman and Archibald, 1978, No. 4)
- C. turgida* Gregory (Hustedt, 1930: 358, f. 660)
- C. ventricosa* Kützing (Hustedt, 1930: 359, f. 661; = *C. minuta* Hilse ex Rabenhorst, cf. Patrick and Reimer, 1975: 47, pl. 8, f. 1–4)
- Denticula* sp. (affin. *tenuis* Kützing var. ?)
- Diatoma vulgare* Bory\* (Hustedt, 1931–59: 96, f. 628a–d; Patrick and Reimer, 1966: 109, pl. 2, f. 9)
- Diploneis oblongella* (Naeg. ex Kützing) Ross (Patrick and Reimer, 1966: 413, pl. 38, f. 8)
- Diploneis smithii* (Brébisson ex W. Smith) Cleve var. *pumila* (Grunow) Hustedt (1931–59: 650, f. 1052d, e; Patrick and Reimer, 1966: 411, pl. 38, f. 4)
- D. subovalis* Cleve (Hustedt, 1931–59: 667, f. 1063a, b)
- Epithemia sorex* Kützing (Schoeman and Archibald, 1976, No. 1)
- Eunotia pectinalis* (Dillwyn ? O. F. Müller?) Rabenhorst (Hustedt, 1931–59: 296, f. 763a; Patrick and Reimer, 1966: 204, pl. 12, f. 8, 10)
- E. pectinalis* var. *minor* (Kützing) Rabenhorst (Hustedt, 1931–59: 298, f. 763d–h; Patrick and Reimer, 1966: 207, pl. 12, f. 13, 14)
- Fragilaria brevistriata* Grunow (Hustedt, 1931–59: 168, f. 676a–e; Patrick and Reimer, 1966: 128, pl. 4, f. 14)
- F. capucina* Desmazières (Hustedt, 1931–59: 144, f. 659a–e)
- F. construens* (Ehrenberg) Grunow (Hustedt, 1931–59: 156, f. 670a–c; Patrick and Reimer, 1966: 125, pl. 4, f. 4)
- F. construens* var. *venter* (Ehrenberg) Grunow (Hustedt, 1931–59: 158, f. 670h–m; Patrick and Reimer, 1966: 126, pl. 4, f. 8, 9)
- F. fonticola* Hustedt (1937–38: 151, pl. 10, f. 61, 62). This taxon may be similar to *Synedra tabulata* (Agardh) Kützing var. *fasciculata* (Agardh) Hustedt (1931–59: 218, f. 710i–l) = *Synedra fasciculata* (Agardh) Kützing var. *truncata* (Greville) Patrick (in Patrick and Reimer, 1966: 142, pl. 5, f. 16)
- F. pinnata* Ehrenberg (Hustedt, 1931–59: 160 figs 671a–i; Patrick and Reimer, 1966: 127, pl. 4, f. 10)
- F. pinnata* var. *lancetula* (Schumann) Hustedt (1931–59: 161, f. 671m–o; Patrick and Reimer, 1966: 128, pl. 4, f. 12)
- F. ?ungeriana* Grunow (Hustedt in A. Schmidt *et al.*, 1874–1959, pl. 298, f. 1–8; Cholnoky, 1956: 71, f. 62–67; 1957a: 53, f. 89–94; cf. Foged, 1978: 64, pl. 8, f. 8–10)
- Fragilaria vaucheriae* (Kützing) Boye



- Petersen (1938: 167; Patrick and Reimer, 1966: 120, pl. 3, f. 14, 15)
- Frustulia vulgaris* (Thwaites) de Toni (Hustedt, 1931–59: 730, f. 1100; Patrick and Reimer, 1966: 309, pl. 22, f. 3)
- F. vulgaris* var. *angusta* Cholnoky (1954: 214, f. 61; Schoeman, 1973: 92)
- Gomphonema acuminatum* Ehrenberg (Patrick and Reimer, 1975: 112, pl. 15, f. 2, 4, 7)
- G. clevei* Fricke (Hustedt, 1937–38: 441, pl. 27, f. 14–18; Patrick and Reimer, 1975: 138, pl. 18, f. 6)
- G. constrictum* Ehrenberg (Hustedt, 1930: 377, f. 714) = *G. truncatum* Ehrenberg (Patrick and Reimer, 1975: 118, pl. 16, f. 3)
- G. constrictum* var. *capitatum* (Ehrenberg) Grunow (Hustedt, 1930: 377, f. 715) = *G. truncatum* Ehrenberg var. *capitatum* (Ehrenberg) Patrick (in Patrick and Reimer, 1975: 119, pl. 16, f. 4)
- G. dichotomum* Kützing (Patrick and Reimer, 1975: 135, pl. 18, f. 2, 3). Small specimens can be only 10 µm long and 3.5 µm broad
- G. intricatum* Kützing (Hustedt, 1930: 375, f. 697; Patrick and Reimer, 1975: 134, pl. 18, f. 1)
- G. intricatum* var. *pumila* Grunow = *G. dichotomum* Kützing
- G. intricatum* var. *vibrio* (Ehrenberg) Cleve (Hustedt, 1930: 376, f. 698; Patrick and Reimer, 1975: 135, pl. 18, f. 4)
- G. lanceolatum* Ehrenberg (Hustedt, 1930: 376, f. 700)
- G. lanceolatum* var. *insignis* (Gregory) Cleve (Hustedt, 1930: 376, f. 701) = *G. affine* Kützing var. *insigne* (Gregory) Andrews (Patrick and Reimer, 1975: 133, pl. 17, f. 4)
- G. parvulum* (Kützing) Kützing (Patrick and Reimer, 1975: 122, pl. 17, f. 7–12)
- G. subclavatum* (Grunow) Grunow (Patrick and Reimer, 1975: 129, pl. 16, f. 10) = *G. longiceps* Ehrenberg var. *subclavatum* Grunow (Hustedt, 1930: 375, f. 705)
- Gomphonema truncatum* Ehrenberg (see *G. constrictum*)
- G. truncatum* var. *capitatum* (Ehrenberg) Patrick (see *G. constrictum* var. *capitatum*)
- Gyrosigma acuminatum* (Kützing) Rabenhorst (Hustedt 1930: 222, f. 329; Patrick and Reimer, 1966: 314, pl. 23, f. 1–3)
- G. attenuatum* (Kützing) Rabenhorst (Hustedt, 1930: 224, f. 330; Patrick and Reimer, 1966: 319, pl. 24, f. 1)
- G. kuetzingii* (Grunow) Cleve (Hustedt, 1930: 224, f. 333). According to Patrick and Reimer (1966: 315) it is a synonym of *G. spencerii* (Quekett) Griffith and Henfrey
- G. scalpoides* (Rabenhorst) Cleve (Schoeman and Archibald, 1978, No. 4)
- G. spencerii* (Quekett) Griffith and Henfrey (Patrick and Reimer, 1966: 315, pl. 23, f. 4; Hustedt, 1930: 225, f. 336)
- G. sp.* 1 [affin. *rautenbachiae* Cholnoky] (1957b: 65, f. 61; 1959: 32, f. 167)
- G. sp.* 2 [affin. *strigilis* (W. Smith) Cleve] (Patrick and Reimer, 1966: 326, pl. 25, f. 5)
- Hantzschia amphioxys* (Ehrenberg) Grunow (Hustedt, 1930: 394, f. 747, 748)
- Melosira granulata* (Ehrenberg) Ralfs (Hustedt, 1927–30: 248, f. 104a–c)
- M. granulata* var. *angustissima* O. Müller (Hustedt, 1927–30: 250, f. 104d)
- M. varians* Agardh (Hustedt, 1927–30: 240, f. 100)
- Navicula acephala* Schoeman (1973: 107, f. 152, 153)
- N. accomoda* Hustedt (Schoeman and Archibald, 1977a, No. 2)
- N. agrestis* Hustedt (1937–38: 246, pl. 20, f. 21, 22; 1961–66: 235, f. 1358; Schoeman, 1973: 108, f. 99)
- N. anglica* Ralfs (Hustedt, 1930: 303, f. 530, 531)
- N. atomus* (Kützing) Grunow (Hustedt, 1930: 288, f. 484; 1961–66: 169, f. 1303; Schoeman, 1973: 110, f. 177–180)
- N. avenacea* (Brébisson) Cleve =

- N. viridula* (Kützing) Kützing var. *avenacea* (Brébisson ex Grunow) Van Heurck (Hustedt, 1930: 297; Patrick and Reimer, 1966: 507, pl. 48, f. 10)
- N. bryophila* Boye Petersen (Hustedt, 1961–66: 91, f. 1237)
- N. capitata* Ehrenberg (Patrick and Reimer, 1966: 536, pl. 52, f. 1, 2)
- N. capitata* var. *hungarica* (Grunow) Ross (Patrick and Reimer, 1966: 537, pl. 52, f. 3)
- N. cari* Ehrenberg (Hustedt, 1930: 299, f. 512)
- N. cincta* (Ehrenberg) Ralfs (Hustedt, 1930: 298, f. 510; Patrick and Reimer, 1966: 516, pl. 49, f. 8; Carter, 1979)
- N. cincta* var. *leptocephala* (Brébisson) Grunow (Hustedt, 1930: 299; Patrick and Reimer, 1966: 515, pl. 49, f. 7 as *N. heufleri* var. *leptocephala* (Brébisson ex Grunow) Peragallo)
- N. confervacea* (Kützing) Grunow (Schoeman and Archibald, 1980, No. 6)
- N. contenta* Grunow (Schoeman and Archibald, 1978, No. 4)
- N. cryptocephala* Kützing (Hustedt, 1930: 295, f. 496; Patrick and Reimer, 1966: 503, pl. 48, f. 3)
- N. cryptocephala* var. *veneta* (Kützing) Rabenhorst (Hustedt, 1930: 295, f. 497a; Patrick and Reimer, 1966: 504, pl. 48, f. 5)
- N. cuspidata* (Kützing) Kützing (Hustedt, 1961–66: 59, f. 1206a, b; Patrick and Reimer, 1966: 464, pl. 43, f. 9, 10)
- N. cuspidata* var. *ambigua* (Ehrenberg ?), Cleve. Not distinguished from the species, cf. Patrick and Reimer, 1966: 464.
- N. dicephala* Ehrenberg (Hustedt, 1930: 302, f. 526)
- N. digitulus* Hustedt (1961–66: 252, f. 1378)
- N. elginensis* (Gregory) Ralfs var. *neglecta* (Krasske) Patrick (in Patrick and Reimer, 1966: 525, pl. 50, f. 5)
- N. exigua* (Gregory) Grunow (Hustedt, 1930: 305, f. 538)
- Navicula fragilarioides* Krasske (Hustedt, 1930: 278, f. 461; 1961–66: 206, f. 1325)
- N. fragalis* Hustedt (Schoeman and Archibald, 1980, No. 6)
- N. goeppertiana* (Bleisch) Grunow (Lange-Bertalot and Bonik, 1978: 33; Hustedt, 1961–66: 585, f. 1592n –t as *N. mutica* forma *goeppertiana* (Bleisch) Grunow)
- N. gracilis* Ehrenberg = *N. tripunctata* (O. F. Müller) Bory
- N. gregaria* Donkin (Schoeman and Archibald, 1978, No. 4)
- N. halophila* (Grunow) Cleve (Schoeman and Archibald, 1977a, No. 2)
- N. hassiaca* Krasske (Hustedt, 1961–66: 216, f. 1332; Patrick and Reimer, 1966: 480, pl. 45, f. 17)
- N. hungarica* Grunow = *N. capitata* Ehrenberg var. *hungarica* (Grunow) Ross
- N. hungarica* var. *capitata* (Ehrenberg) Cleve = *N. capitata* Ehrenberg
- N. krasskei* Hustedt (Schoeman and Archibald, 1976, No. 1)
- N. lanceolata* (Agardh) Kützing (*sensu* Grunow in Van Heurck, 1880–85, pl. 8, f. 16; Schoeman, 1973: 134, f. 109–113; Patrick and Reimer, 1966: 511, pl. 48, f. 19, 20)
- N. menisculus* Schumann (Hustedt, 1930: 301, f. 517; Schoeman, 1973: 137, f. 122, 123)
- N. minima* Grunow (Hustedt, 1961–66: 249, f. 1374; Patrick and Reimer, 1966: 488, pl. 46, f. 17, 18)
- N. monoculata* Hustedt (Schoeman and Archibald, 1979, No. 5)
- N. muralis* Grunow (*sensu* Schoeman, 1973) = *N. perinitis* Hustedt
- N. mutica* Kützing (Hustedt, 1961–66: 583; Lange-Bertalot and Bonik, 1978: 33)
- N. perinitis* Hustedt (Lange-Bertalot and Bonik, 1976: 308, f. 1a, 2, 5, 6)
- N. pupula* Kützing (Schoeman and Archibald, 1979, No. 5)
- N. pygmaea* Kützing (Schoeman and Archibald, 1980, No. 6)
- N. radiosa* Kützing (Hustedt, 1930: 299, f. 513; Patrick and Reimer, 1966: 509, pl. 48, f. 15)

- Navicula radiosa* var. *tenella* (Brébisson ex Kützing) Grunow (Patrick and Reimer, 1966: 510, pl. 48, f. 17; Schoeman, 1973: 162, f. 119, 120)
- N. rostellata* Kützing (Hustedt, 1930: 297, f. 502)
- N. salinarum* Grunow var. *intermedia* (Grunow) Cleve (Patrick and Reimer, 1966: 503, pl. 48, f. 2)
- N. saprophila* Lange-Bertalot & Bonik (Schoeman and Archibald, 1980, No. 6)
- N. schroeteri* Meister (1932: 38, f. 100; Hustedt, 1937–38: 267, pl. 18, f. 16)
- N. seminuloides* Hustedt (1961–66: 244, f. 1369)
- N. seminulum* Grunow (Schoeman and Archibald, 1977b, No. 3)
- N. stroemii* Hustedt (1961–66: 129, f. 1262)
- N. subbacillum* Hustedt (1961–66: 117, f. 1251)
- N. subhamulata* Grunow (Hustedt, 1961–66: 126, f. 1258; Patrick and Reimer, 1966: 495, pl. 47, f. 6)
- N. subrotundata* Hustedt (1961–66: 272, f. 1402a–m)
- N. tantula* Hustedt (1961–66: 250, f. 1375)
- N. tenella* Brébisson (see *N. radiosa* var. *tenella*)
- N. tenelloides* Hustedt (Schoeman and Archibald, 1976, No. 1)
- N. terrestris* J. Boye Petersen (1915: 288, f. 7, 8; Lund, 1946: 80, f. 7M–T; Schoeman, 1969: 57, f. 27, 28, 33, 34)
- N. tridentula* Krasske (Hustedt, 1961–66: 82, f. 1223)
- N. tripunctata* (O. F. Müller) Bory (Patrick and Reimer, 1966: 513, pl. 49, f. 3). Synonym = *N. gracilis* Ehrenberg (Hustedt, 1930: 299, f. 514)
- N. twymaniana* Archibald (Schoeman and Archibald, 1977a, No. 2)
- N. vasta* Hustedt (1937–38: 273, pl. 19, f. 19–21)
- N. ventosa* Hustedt (1961–66: 234, f. 1357)
- N. vulpina* Kützing (Hustedt, 1930: 297, f. 504; Patrick and Reimer, 1966: 531, pl. 50, f. 19)
- Navicula* sp. 1 (affin. *cryptocephala* Kützing). Recorded from stations 13 and 13A
- N.* sp. 2 (affin. *twymaniana* Archibald). Recorded from stations 11B and 13
- Neidium affine* (Ehrenberg) Pfitzer (Hustedt, 1930: 242, f. 376; Patrick and Reimer, 1966: 390, pl. 35, f. 2)
- Nitzschia accomodata* Hustedt (1949a: 139, pl. 12, f. 27–31, 34, 35; Schoeman, 1973: 172)
- N. acicularis* (Kützing) W. Smith (1930: 423, f. 821)
- N. adapta* Hustedt (1949a: 135, pl. 12, f. 3–6; Schoeman, 1973: 173)
- N. agnewii* Cholnoky (1962a: 94, f. 18, 19; Schoeman, 1973: 174, pl. 6, f. 211)
- N. agnita* Hustedt (1957: 347, f. 51; Schoeman, 1973: 174, f. 212). According to Lange-Bertalot and Simonsen (1978: 16, f. 151) this taxon is a synonym of *N. pumila* Hustedt.
- N. alexandrina* (Cholnoky) Lange-Bertalot and Simonsen (1978: 16, f. 196, 197, 285, 286; = *N. elliptica* Hustedt var. *alexandrina* Cholnoky, 1958: 258, f. 29, 30; 1963: 246, f. 25–27; Schoeman, 1973: 183, f. 215)
- N. allansonii* Cholnoky (1958: 257, f. 24–27; Schoeman, 1973: 174, f. 223)
- N. amphibia* Grunow (Hustedt, 1930: 414, f. 793)
- N. apiculata* (Gregory) Grunow (Schoeman and Archibald, 1976, No. 1)
- N. archibaldii* Lange-Bertalot (1980: 44, f. 14–18, 115–121)
- N. aurantiaca* Schoeman (1973: 176, f. 204–207) Specimens may measure up to 75  $\mu$ m in length
- N. bacata* Hustedt (1937–38: 485, pl. 41, f. 30–33; Schoeman, 1973: 177, f. 227). Lange-Bertalot and Simonsen (1978: 19, f. 207–209) regard this taxon as a synonym of *N. paleacea*
- N. chasei* Cholnoky = *Simonsenia delognei* (Grunow) Lange-Bertalot
- N. clausii* Hantzsch (Hustedt, 1930: 421, f. 814; Schoeman, 1973: 179)
- N. coarctata* Grunow (in Cleve and Grunow, 1880: 68; in Van Heurck,

- 1880–83, pl. 57, f. 4; Peragallo and Peragallo, 1897–1908, pl. 69, f. 26–30)
- Nitzschia communis* Rabenhorst (Schoeman and Archibald, 1977a, No. 2)
- N. confinis* Hustedt (1949a: 145, pl. 11, f. 49–54, pl. 13, f. 84–90; Schoeman, 1973: 181)
- N. denticula* Grunow (Hustedt, 1930: 407, f. 780)
- N. denticula* var. *delognei* Grunow = *N. sinuata* (W. Smith) Grunow var. *delognei* Lange-Bertalot
- N. dissipata* (Kützing) Grunow (Schoeman and Archibald, 1976, No. 1)
- N. elliptica* Hustedt var. *alexandrina* Cholnoky = *N. alexandrina* (Cholnoky) Lange-Bertalot and Simonsen
- N. filiformis* (W. Smith) Van Heurck (Hustedt, 1930: 422, f. 818; 1949a: 151, pl. 11, f. 59, 60)
- N. fonticola* Grunow (in Cleve and Grunow, 1880: 97; in Van Heurck, 1880–83, pl. 69, f. 15–19; Lange-Bertalot, 1977: 270, pl. 3, f. 7–11)
- N. frequens* Hustedt (1957: 348, f. 52–54; Schoeman, 1973: 184, f. 217, 218). Lange-Bertalot and Simonsen (1978: 23, f. 71, 72) regard this species as a synonym of *N. gandersheimiensis* Krasske
- N. frustulum* (Kützing) Grunow (Lange-Bertalot and Simonsen, 1978: 23, f. 1–39, 292, 293)
- N. gandersheimiensis* Krasske (Lange-Bertalot and Simonsen, 1978: 28, f. 40–53, 60–112, 289)
- N. hantzschiana* Rabenhorst (Hustedt, 1930: 415, f. 797; Lange-Bertalot, 1977: 263, pl. 2, f. 14–21)
- N. heufferiana* Grunow (1862: 575; in Van Heurck, 1880–83, pl. 68, f. 13, 14; Lange-Bertalot, 1977: 260, pl. 1, f. 20, 21, pl. 10, f. 5; Lange-Bertalot and Simonsen, 1978: 39, f. 232, 233 under *N. lauenburgiana* Hustedt)
- N. hungarica* Grunow (Schoeman and Archibald, 1976, No. 1)
- N. immunda* Archibald (1966: 231, f. 14)
- N. ignorata* Krasske (Hustedt, 1930: 422, f. 819)
- N. intermedia* Hantzsch ex Cleve & Grunow (Lange-Bertalot, 1977: 267, pl. 4, 5, 6; Lange-Bertalot and Simonsen, 1978: 22, f. 47, 48, 49, 51, under *N. capitellata* Hustedt; Schoeman, 1973: 186)
- Nitzschia interrupta* (Reichelt) Hustedt = *N. sinuata* var. *delognei* Lange-Bertalot
- N. kuetzingioides* Hustedt = *N. pumila* Hustedt (Lange-Bertalot and Simonsen, 1978: 38, f. 152–154)
- N. latens* Hustedt (1949a: 148, pl. 13, f. 30, 31)
- N. lauenburgiana* Hustedt (1950: 402, pl. 40, f. 6, 7, 9–11) = *N. heufferiana* Grunow
- N. levidensis* (W. Smith) Grunow = *N. tryblionella* Hantzsch var. *levidensis* (W. Smith) Grunow
- N. linearis* (Agardh) W. Smith (Hustedt, 1930: 409, f. 784)
- N. microcephala* Grunow (Hustedt, 1930: 414, f. 791; Lange-Bertalot, 1980: 51, f. 28, 29, 152–154)
- N. obligata* Archibald (1966: 233, f. 20; 1971: 52, f. 217, 218; Schoeman, 1973: 194, f. 203). This taxon is possibly a synonym of *N. agnita* Hustedt
- N. obtusa* W. Smith (Hustedt, 1930: 422, f. 817a–c)
- N. obtusa* var. *scalpelliformis* Grunow (Hustedt, 1930: 422, f. 817d)
- N. palea* (Kützing) W. Smith (Hustedt, 1930: 416, f. 801; Lange-Bertalot, 1977: 271, pl. 3, f. 17–25)
- N. paleacea* Grunow (in Cleve and Grunow, 1880: 95, as a variety of *N. subtilis*; in Van Heurck, 1880–83, pl. 68, f. 9, 10; Lange-Bertalot, 1977: 257, pl. 1, f. 5–16, pl. 8, f. 1–3)
- N. perminuta* Grunow (*sensu* Hustedt, as *N. frustulum* var. *perminuta*). Lange-Bertalot (1977: 263, pl. 2, f. 9, 10) has shown that specimens of this taxon (*sensu* Hustedt) belong to *N. frustulum* which displays a wide range of variation
- N. perpusilla* Rabenhorst (*sensu* Hustedt, as *N. frustulum* var. *perpusilla*). Lange-Bertalot and Simonsen (1978: 23, as *N. frustulum*) have shown that this taxon (*sensu* Hustedt) belongs to the *N. frustulum* range



- Nitzschia pilum* Hustedt = *N. palea* (Kützing) W. Smith (cf. Lange-Bertalot and Simonsen, 1978: 43)
- N. pumila* Hustedt (Lange-Bertalot and Simonsen, 1978: 45, f. 149, 150)
- N. punctata* (W. Smith) Grunow var. *coarctata* Grunow = *N. coarctata* Grunow
- N. pusilla* (Kützing) Grunow emend. Lange-Bertalot (1977: 273, pl. 7, f. 1-10, pl. 9, f. 5, 6)
- N. recta* Hantzsch (Hustedt, 1930: 411, f. 785)
- N. romana* Grunow (in Cleve and Grunow, 1880: 97 as *N. kuetzingiana* var. *romana*; in Van Heurck, 1880-83, pl. 69, f. 12; Lange-Bertalot, 1977: 269, pl. 3, f. 1-6)
- N. sigma* (Kützing) W. Smith (Hustedt, 1930: 420, f. 813)
- N. silica* Archibald (1966: 234, f. 22-24)
- N. sinuata* (W. Smith) Grunow var. *delognei* Lange-Bertalot (1980: 54, f. 77-86, 155, 156)
- N. sinuata* var. *tabellaria* (Grunow) Grunow (Hustedt, 1930: 409, f. 782; Lange-Bertalot, 1980, pl. 4, f. 75, 76)
- N. spiculoides* Hustedt (1949a: 151, pl. 13, f. 5, 6)
- N. subcapitellata* Hustedt (1939: 663, f. 109; 1957: 354, f. 63-65; Lange-Bertalot and Simonsen, 1978: 51, f. 69, 70). According to Lange-Bertalot et al. (l.c.) this taxon should be treated as a later synonym of *N. ganders-heimiensis*
- N. thermalis* Kützing (*sensu* Grunow; Hustedt, 1930: 403, f. 771) = *N. umbonata* (Ehrenberg) Lange-Bertalot (1978b: 648)
- N. tropica* Hustedt (1949a: 147, pl. 11, f. 34-48)
- N. tryblionella* Hantzsch (Hustedt, 1930: 399, f. 757)
- N. tryblionella* var. *levidensis* (W. Smith) Grunow (Hustedt, 1930: 399, f. 760)
- N. tryblionella* var. *victoriae* (Grunow) Grunow (Hustedt, 1930: 399, f. 758)
- N. umbonata* (Ehrenberg) Lange-Bertalot (1978b: 648, f. 1-21, 38)
- Pinnularia acoricola* Hustedt (1935: 159, pl. 3, f. 24a, b; 1937-38: 293, pl. 21, f. 11-16)
- P. acrosphaeria* W. Smith (Hustedt, 1930: 330, f. 610; Patrick and Reimer, 1966: 623, pl. 60, f. 2, 3)
- P. appendiculata* (Agardh) Cleve (Hustedt, 1930: 317, f. 570a; Patrick and Reimer, 1966: 593, pl. 55 f. 2)
- P. biceps* Gregory (Patrick and Reimer, 1966: 599, pl. 55, f. 14, 15)
- P. borealis* Ehrenberg (Hustedt, 1930: 326, f. 597; Patrick and Reimer, 1966: 618, pl. 58, f. 13)
- P. ?eburnea* Zanon (1941: 49, pl. 3, f. 16-19; Cholnoky 1960a: 108, f. 324-331; Schoeman, 1973: 207)
- P. gibba* (Ehrenberg) W. Smith (*sensu* Hustedt, 1930: 327, f. 600)
- P. gibba* var. *sancta* (Grunow) Meister (Guermeur, 1954: 64; pl. 15, f. 1a-e)
- P. interrupta* W. Smith (Hustedt, 1930: 317, f. 573) = *P. biceps* Gregory
- P. mesolepta* (Ehrenberg) W. Smith (Hustedt, 1930: 319, f. 575a; Patrick and Reimer, 1966: 600, pl. 55, f. 17, 18)
- P. subcapitata* Gregory (Patrick and Reimer, 1966: 596, pl. 55, f. 8-10)
- Rhopalodia gibba* (Ehrenberg) O. Müller (Hustedt, 1930: 390, f. 740; Patrick and Reimer, 1975: 189, pl. 28, f. 1)
- R. gibberula* (Ehrenberg) O. Müller (Hustedt, 1930: 391, f. 742; Patrick and Reimer, 1975: 191, pl. 28, f. 6; Schoeman and Ashton 1981)
- Simonsenia delognei* (Grunow) Lange-Bertalot (1979c: 132, f. 1-19)
- Stauroneis anceps* Ehrenberg (Hustedt, 1931-59: 771, f. 1120a; Patrick and Reimer; 1966: 361, pl. 30, f. 1)
- S. borrichii* (Boye Petersen) Lund (Hustedt, 1931-59: 803, f. 1151)
- S. nana* Hustedt (1931-59: 793, f. 1145; Patrick and Reimer, 1966: 363, pl. 30, f. 6; Schoeman, 1973: 229 f. 241, 242)
- S. smithii* Grunow (Hustedt, 1931-59: 810, f. 1157a-e; Patrick and Reimer, 1966: 365, pl. 30, f. 12)



- Stauroneis* sp. 1 (affin. *dahomensis* Hustedt *sensu* Archibald, 1971: 58, f. 272)
- Stephanodiscus astrea* (Ehrenberg) Grunow var. *minutula* (Kützing) Grunow (Hustedt, 1927–30: 369, f. 193d, e) = *S. rotula* (Kützing) Hendey var. *minutula* (Kützing) Ross and Sims (1978: 152)
- S. hantzschii* Grunow (Hustedt, 1927–30: 370, f. 194)
- S. rotula* (Kützing) Hendey var. *minutula* (Kützing) Ross and Sims (Hustedt, 1927–30: 369, f. 193d, e, as *S. astrea* var. *minutula*)
- Surirella angusta* Kützing (Hustedt 1930: 435, f. 844, 845, as *S. angustata*). According to Lange-Bertalot (1979a: 197) it is a synonym of *S. ovalis* Brébisson
- S. ovalis* Brébisson (Hustedt, 1930: 441, f. 860, 861; Lange-Bertalot, 1979a: 197, f. 20–24)
- S. ovata* Kützing (Hustedt, 1930: 442, f. 863, 864). Lange-Bertalot (1979a: 197) regards it as a synonym of *S. ovalis*
- S. tenera* Gregory (Hustedt, 1930: 438, f. 853)
- Synedra acus* Kützing (Hustedt, 1931–59: 201, f. 693a; Patrick and Reimer, 1966: 135, pl. 5, f. 1)
- S. acus* var. *angustissima* Grunow (Hustedt, 1931–59: 202, f. 693c). Patrick and Reimer (1966: 136, pl. 5, f. 3) treat this taxon as a synonym of *S. delicatissima* W. Smith var. *angustissima* Grunow
- S. acus* var. *radians* (Kützing) Hustedt (1931–59: 202, f. 693b). According to Patrick and Reimer (1966: 137, pl. 5, f. 4) this taxon is synonymous with *S. radians* Kützing.
- S. allansonii* Cholnoky (1958: 262, f. 33, 34; 1962b: 338, f. 46)
- Synedra fasciculata* (Agardh) Kützing. See *S. tabulata*.
- S. nana* Meister (1912: 76, pl. 8, f. 9; Hustedt, 1931–59: 212, f. 704)
- S. parasitica* (W. Smith) Hustedt (1931–59: 204, f. 695a, b; Patrick and Reimer, 1966: 140, pl. 5, f. 12)
- S. rumpens* Kützing (Hustedt, 1931–59: 207, f. 697a, b; Patrick and Reimer, 1966: 143, pl. 5, f. 19)
- S. rumpens* var. *familiaris* (Kützing) Hustedt (1931–59: 207, f. 697c; Patrick and Reimer, 1966: 143, pl. 5, f. 20). Hustedt (1957: 229) transferred this taxon to the genus *Fragilaria*, as *F. familiaris* (Kützing) Hustedt.
- S. tabulata* (Agardh) Kützing (Hustedt, 1931–59: 218, f. 710a–d; Patrick and Reimer, 1966: 141, pl. 5, f. 17, 18, as *S. fasciculata*)
- S. tabulata* var. *fasciculata* (Kützing) Hustedt (1931–59: 218, f. 710i–1) = *S. fasciculata* (Agardh) Kützing var. *truncata* (Greville) Patrick (in Patrick and Reimer, 1966: 142, pl. 5, f. 16). This taxon may be similar to *Fragilaria fonticola* Hustedt
- S. tenera* W. Smith (Hustedt, 1931–59: 211, f. 703; Patrick and Reimer, 1966: 137, pl. 5, f. 5)
- S. ulna* (Nitzsch) Ehrenberg\* (Hustedt, 1931–59: 195, f. 691Aa–g; Patrick and Reimer, 1966: 148, pl. 7, f. 1, 2). In the present study no distinction was made between the various forms and varieties of this taxon
- Thalassiosira fluviatilis* Hustedt (Schoeman and Archibald, 1977a, No. 2)

\*Note: The relationship between *Synedra allansonii*, *S. nana* and *S. tenera* should be carefully examined for possible synonymy.

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## COMPARATIVE ANATOMY OF MATURE *THEMEDA TRIANDRA* FORSK. LEAF BLADES: A CORRELATED LIGHT AND ELECTRON MICROSCOPE STUDY

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### ABSTRACT

Aspects of the anatomy of mature leaf blades of *Themeda triandra* Forsk. from the Fish River, Alice and Hogsback provenances were investigated with light and electron microscopes. The blades contain three orders of vascular bundle, each of which is surrounded by a bundle sheath consisting of relatively thick-walled, chlorenchymatous cells with centrifugally arranged, agranal chloroplasts. The bundle-sheath walls are variably lignified; in addition, the outer tangential and radial walls contain a continuous suberin lamella, which is widest at the sites of the plasmodesmatal aggregates. The phloem in all three vein orders has both thick- and thin-walled sieve tubes similar to those recorded in the longitudinal bundles of other grasses. In median and large (first-order) bundles, the phloem is bordered laterally by a layer of thick-walled cells. The laminae of specimens from Hogsback and Alice contained a greater percentage volume of air space (6,68 % and 6,06 %, respectively) than that from Fish River (3,78 %).

### UITTREKSEL

#### DIE VERGELYKENDE ANATOMIE VAN VOLWASSE *THEMEDA TRIANDRA* FORSK. BLARE: 'N GEKORRELEERDE LIG- EN ELEKTRONMIKROSKOOP STUDIE

Die anatomie van volwasse *Themeda triandra* blare, afkomstig uit die Visrivier-, Alice- en Hogsback-gebiede, is deur middel van lig- en elektronmikroskopie bestudeer. Die drie herkenbare aarordes is in die blare, omring deur 'n eenlagige bondelskede wat uit taamlike dikwandige selle bestaan. Teen die buitenste tangensiale en radiale bondelskede wande kom korrellose chloroplaste voor. Die bondelskede se buitenste tangensiale en radiale wande besit 'n suberien lamella, wat verdik is waar die plasmodesmata, wat in primêre stippel velde gerangskik is, deurdring. Die phloem van al drie aarordes besit dik en dun wandige phloem – altesaam dieselfde as wat in ander grassoorte tevore beskryf is. Die grootaar en ook die van die primêre aarorde van die blaas, is omring deur 'n laag dikwandige selle. Groter inter. blêre lugruimte is ontwikkel in blare afkomstig van Hogsback (6,68 %) en Alice (6,06 %), as wat die geval is met *T. triandra* van die Visriviergebied (3,78 %).

## 1. INTRODUCTION

*Themeda triandra* Forsk. – four varieties of which are recognised by Chippindall in Meredith (1955) – forms part of the climax succession stage in savanna areas of Southern Africa. In the Eastern Cape, *T. triandra* var. *imberbis* occurs in at least three, differing veld types under widely differing climate regimes: from the low-lying, hot, semi-arid Fish River Valley area to the relatively cool, moist highland Hogsback area, with the Alice area intermediate between the two extremes (Acocks, 1975). The foliage leaves of plants from Fish River and Alice provenances are generally more glabrous and narrow than those of plants from the Hogsback provenance.

The anatomy of *Themeda* has been described by Goosens and Theron (1934) at the light microscope level, based on freehand sections and drawings made from these sections. It was felt that the illustrations in Goosens and Theron (1934) contain inaccuracies which precluded the use of much of the descriptive leaf anatomy of *Themeda* in these authors' paper.

The present study was undertaken to determine whether any anatomical differences existed in the leaves of plants from the three provenances – differences that might be attributed to the widely differing conditions under which this  $C_4$  grass grows.

## 2. MATERIAL AND METHODS

*T. triandra* var. *imberbis* (Retz.) A. Camus tillers from Fish River, Alice and Hogsback provenances were collected from experimental plots established by Downing and Marshall (1980) in 1979. Tillers were potted and transferred to conviron EF 7-H environmental cabinets where they were grown under the following climatic regimes: *Themeda* (Fish River) 30°C max., 20°C min.; 16h photoperiod; RH 65 % max., 50 % min. *Themeda* (Alice) 28°C max., 18°C min.; 16h photoperiod; RH 70 % max., 50 % min. *Themeda* (Hogsback) 25°C max., 12°C min.; 16h photoperiod, RH 80 % max., 60 % min. Voucher specimens are lodged at both the University of Fort Hare and the National Herbarium, Pretoria, South Africa (Botha<sup>1</sup>, Fish River; Botha<sup>2</sup>, Alice; Botha<sup>3</sup>, Hogsback).

### 2.1. Fixation and Embedment

Tissues from the mid third of fully-expanded, mature laminae were selected and cut into small pieces approximately 3 × 5 mm. Samples were fixed on either 3 % or 6 % glutaraldehyde in buffer (0.05 or 0.025 M phosphate or cacodylate at pH 7.2). Cold fixation was carried out for 24 h, with frequent changes of the buffered fixative. The material was then trimmed into smaller pieces (approximately 2 × 2 mm), rinsed in the appropriate buffer and fixed in 2 % osmium tetroxide, which was made up in the

appropriate buffer solutions. Dehydration was in an alcohol series, followed by two changes in propylene oxide. Embedment was in Spurr's (1969) low viscosity resin.

## 2.2. Light and Electron Microscopy

Serial transverse, longitudinal, and paradermal sections, 0.5 to 2.0  $\mu\text{m}$  thick, were cut with glass knives, on an LKB Ultratome III. Such sections were routinely stained in 0.005 % aqueous toluidine blue-O, or aqueous methylene blue, pH 6.8 followed by 0.05 % neo-fuchsin, on a hotplate for 30 seconds to 1 minute (all Merck chemicals).

Serial transverse 15  $\mu\text{m}$ -thick sections were cut on a Leitz freezing microtome and stained with Sudan IV, for the presence of suberin, and ruthenium red for pectic material. Similar sections were treated with Phloroglucinol-HCl for the presence of lignins (Johansen, 1940). Results were recorded on film with integral 35 mm and  $90 \times 120$  mm plate cameras on a Zeiss Photomicroscope III fitted with brightfield, phase and Nomarski interference contrast objectives.

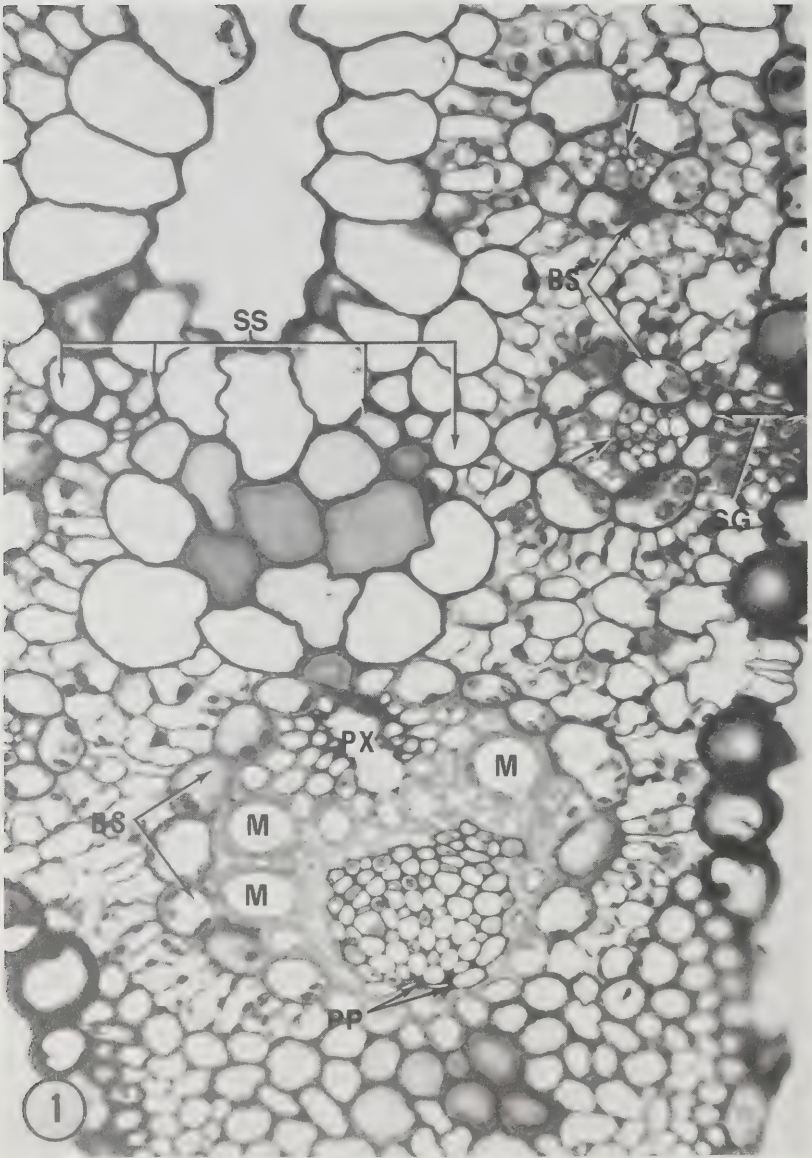
Ultra-thin serial sections were cut with diamond knives (DuPont), stained in uranyl acetate and lead citrate and viewed with an Hitachi HU-IIB electron microscope.

## 2.3. Leaf Air Space Volume

Segments  $10 \text{ mm} \times 4 \text{ mm}$  were excised from the mid portion of fully expanded laminae. Ten similar-sized leaves were used for each of the above collections, the combined segments were weighed on a four decimal place Sartorius balance. The leaf material was immersed in a beaker containing 1 % Extran (Merck chemicals), to help break the surface tension, placed in a dessicator, and subjected to a mild vacuum (-500 mbar) for 4 min. The vacuum was released rapidly, and re-applied for a further three infiltrations, after which the segments were removed, blotted dry of surface water and quickly weighed. Segments were considered to be surface-dry if no sheen was visible on leaf surfaces. Experiments were replicated four times for each provenance. The technique used here is in essence, similar to that previously reported by Byott (1976).

## 3. RESULTS

For the sake of brevity, the three provenances of *Themeda triandra* reported on herein will be referred to a *Themeda* Fish River (TFR), *Themeda* Alice (TA), and *Themeda* Hogsback (TH). Where no distinctions are made, descriptions apply equally to all three provenances.





### 3.1. Brief Description of the Leaf Blade

The mature leaf blades of *T. triandra* are narrow and tapering. As viewed in transverse section, they are either shallow or steeply V-shaped, and exhibit the Kranz structure typical of  $C_4$  grasses: a concentric radial layering of mesophyll and chloroplast-rich bundle-sheath cells around the vascular bundles. The vascular bundles together with their associated Kranz layers (the bundle sheath and Kranz mesophyll) are separated from one another by narrow zones of non-Kranz mesophyll cells, or so-called 'translucent cells' (Ellis, 1976).

In addition to a median bundle, three orders, or classes, of vascular bundles can be recognized:

- (a) First order, or large, bundles (Figs 2, 4). These bundles are characterised by the presence of large metaxylem vessels on either side of the protoxylem, which often is represented by a lacuna. Obliterated protophloem is evident on the abaxial surface. Conspicuous sclerenchyma girders extend from the bundles to both upper and lower epidermis.
- (b) Second order, or intermediate, bundles (Figs 1, 2, 6). These bundles lack large metaxylem vessels and protoxylem lacunae. Hypodermal sclerenchyma strands or girders occur on both ad- and abaxial surfaces, or on the abaxial surface only.
- (c) Third order, or small, bundles (Figs 1, 2, 4, 6, 8). In addition to lacking large metaxylem vessels and protoxylem lacunae, these bundles are not associated with either hypodermal sclerenchyma strands or girders.

### 3.2 Detailed Description of the Vascular Bundles

#### 3.2.1 Median Bundle

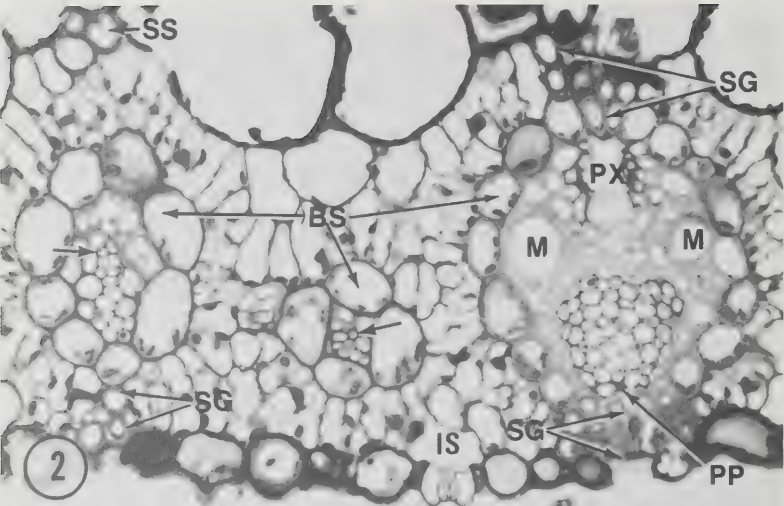
The midrib contains a single median bundle bordered on both sides by chlorenchymatous bundle-sheath cells, which are in direct contact with Kranz mesophyll cells. On both upper and lower sides of the bundle, the sheath cells are virtually achlorophyllous. The ground tissue above the bundle consists of large parenchyma cells and below of collenchymatous cells. The cells of the upper epidermis are bulliform cells.

The median bundle in Figure 1 (TFR) is representative of the median bundles in all three provenances. Like the large bundles, median bundles contain large metaxylem vessels on either side of a protoxylem lacuna. In

FIG. 1.

Transection of part of mature *Themeda* (Fish River) leaf blade, showing (bottom to top) median, intermediate, and small vascular bundles. BS = chlorenchymatous bundle-sheath cells; M = metaxylem vessel; PP = obliterated protophloem; PX = protoxylem lacuna; SG = sclerenchyma girder; SS = sclerenchyma strand; unlabelled arrows point to thick-walled sieve tubes. Toluidine blue. X 660.





the median bundle of Figure 1 two large vessels are found on the left and only one on the right. As many as four large vessels may be present, with two on both sides of the lacuna. The large metaxylem vessels are always in direct contact with the chlorenchymatous bundle sheath cells. The protoxylem lacuna is bordered laterally by nonlignified parenchyma cells and abaxially by a row of metaxylem elements that extend toward the large metaxylem vessels on either side.

The median bundle contains both protophloem and metaphloem. By the time the median bundle is mature, the protophloem, which occurs on the lower surface, is obliterated. The remaining metaxylem consists of sieve-tube members and parenchymatous elements, including companion cells. Laterally, the phloem is separated from the chlorenchymatous bundle sheath by a layer of thick-walled cells.

### 3.2.2. Large Bundles

Figures 2 and 4 provide transverse views of large bundles from Fish River and Alice provenances, respectively. The large bundles of *T. Hogsback* are similar to these.

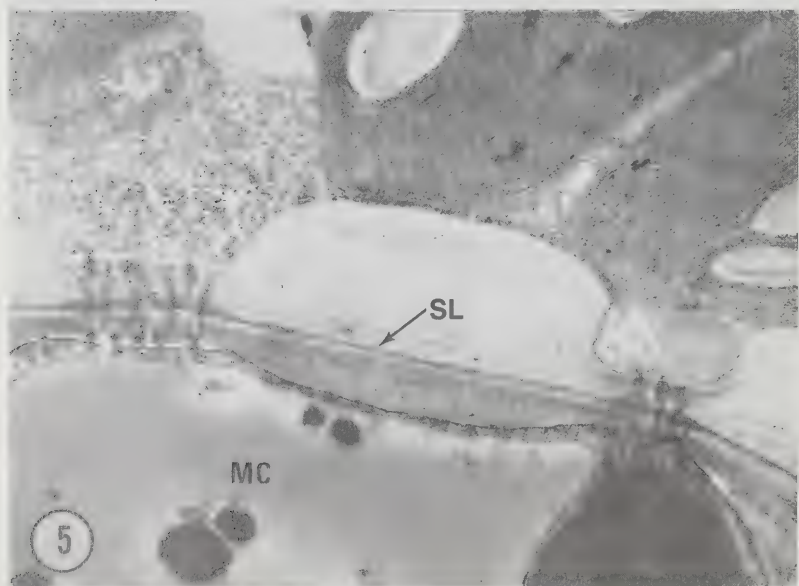
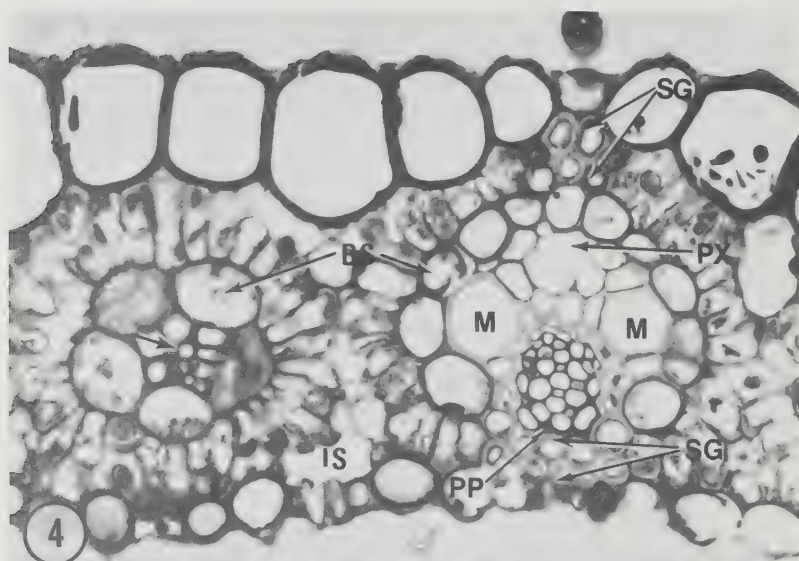
As mentioned previously, the large bundles contain large metaxylem vessels and a protoxylem lacuna. No more than two such vessels—one on either side of the lacuna—have been encountered in any large bundle. The protoxylem lacuna in the large bundle of Figure 4 is smaller, and less conspicuous than that in the large bundle of Figure 2. Similar variation may be encountered among bundles of the same leaf section. A secondary wall thickening of an intact protoxylem element can be seen beneath

FIG. 2.

Transection of part of mature *Themeda* (Fish River) leaf blade, showing (left to right) intermediate, small, and large vascular bundles. Both intermediate and small bundles are entirely surrounded by a chlorenchymatous bundle sheath (BS); that of the large bundle is disrupted ad- and abaxially by sclerenchyma girders (SG). IS = intercellular space; M = metaxylem vessel; PP = obliterated protophloem; PX = protoxylem lacuna; SS = sclerenchyma strand; unlabelled arrows point to thick-walled sieve tubes. Toluidine blue. X 560.

FIG. 3.

Electron micrograph showing a chlorenchymatous bundle-sheath cell, which was associated with a small vascular bundle in a leaf blade of *Themeda* (Fish River). The agranal chloroplasts contain numerous starch grains. A suberin lamella (SL) can be seen in the outer tangential and radial walls of this cell. The arrowheads point to aggregates of plasmodesmata in walls between bundle-sheath cells (above, left), and between the bundle-sheath cell and a mesophyll cell (right, with widened suberin lamella). IS = intercellular space; MC = mesophyll cell; N = nucleus of bundle-sheath cell. 3% glutaraldehyde, 2% OsO<sub>4</sub> in 0.025 M phosphate buffer. X 10500.



the lacuna in Figure 2. Nonlignified parenchyma cells may or may not border the lacuna. Relatively small metaxylem elements bridge the gap between large metaxylem vessels, which are in direct contact with the chlorophyllous bundle sheath.

The large bundles contain both protophloem and metaphloem. As in the median bundle, the protophloem is obliterated. Although not always apparent with the light microscope, the electron microscope has revealed that the metaphloem contains two kinds of sieve tubes, thin-walled ones and thick-walled ones. The thick-walled sieve tubes are among the last to form and occur just outside the xylem. Both phloem parenchyma cells and companion cells are found in large bundles.

All large bundles are associated with sclerenchyma girders, some of which are merely in contact with the chlorenchymatous bundle sheath; others actually disrupt it. In Figure 2, the chlorenchymatous sheath of the large bundle is disrupted on both ad- and abaxial surfaces, whilst that of the large bundle in Figure 4 is disrupted on the abaxial surface only. Notice the layer of thick-walled cells bordering the phloem immediately inside the chlorenchymatous bundle sheath.

### 3.2.3. Intermediate Bundles

Unlike median and large bundles, intermediate bundles lack protoxylem lacunae and large metaxylem vessels typically associated spatially with such lacunae. Although the xylem consists entirely of metaxylem, both protophloem and metaphloem may be present.

The phloem consists of sieve-tube members, companion cells, and parenchyma cells. Distinct xylem parenchyma cells apparently are lacking in most intermediate bundles. Parenchyma cells in direct contact with tracheary elements generally are also in direct contact with sieve tubes. Moreover, the

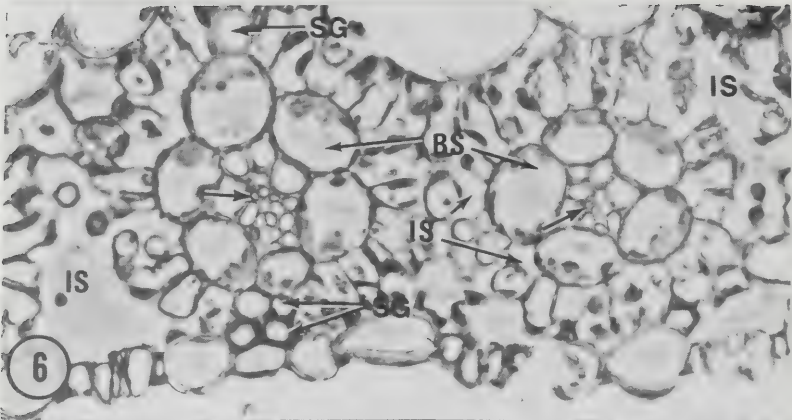
FIG. 4.

Transection of part of mature *Themeda* (Alice) leaf blade, showing small (left) and large (right) vascular bundles. The chlorenchymatous bundle sheath (BS) of the large bundle is disrupted only abaxially by a sclerenchyma girder (SG). IS = intercellular space; M = metaxylem vessel; PP = obliterated protophloem; PX = protoxylem lacuna; unlabelled arrow points to thick-walled sieve tube in small bundle. Toluidine blue. X 680.

FIG. 5.

Electron micrograph showing aggregates of plasmodesmata in mesophyll bundle-sheath cell wall of *Themeda* (Alice) leaf blade. Note that the suberin lamellae (SL) is wider at the sites of plasmodesmata. Portions of agranal chloroplasts can be seen in the bundle-sheath cell (above). MC = mesophyll cell. 6% glutaraldehyde, 2% OsO<sub>4</sub> in 0.05 M phosphate buffer. X 21 600.







contents of these highly vacuolate cells differ little, if any, from those of the parenchyma cells of the phloem. For these reasons, all of the parenchymatous cells of intermediate bundles, with the notable exception of companion cells, will be referred to as "vascular parenchyma cells." All intermediate bundles apparently contain both thin- and thick-walled sieve tubes. The thick-walled sieve tubes often are in direct contact with tracheary elements.

As mentioned previously, intermediate bundles are associated with hypodermal sclerenchyma strands or girders on both ad- or abaxial surfaces, or on abaxial surfaces only. Figures 1, 2 and 6 serve especially to illustrate this aspect. Most of the intermediate bundles are completely enclosed by a chlorenchymatous bundle sheath. The bundle sheath of the intermediate bundle in Figure 1, however, is almost disrupted on its abaxial surface by a hypodermal sclerenchyma girder. On its adaxial surface, an extension of the bundle sheath is in contact with a hypodermal sclerenchyma strand. In Figure 2, the chlorenchymatous bundle sheath is almost completely encircled by Kranz mesophyll cells, as the hypodermal sclerenchyma strand, above, lacks contact with the bundle sheath; below is a small girder.

Finally, in Figure 6, small girders occur both above and below the intermediate bundle.

#### 3.2.4. Small Bundles

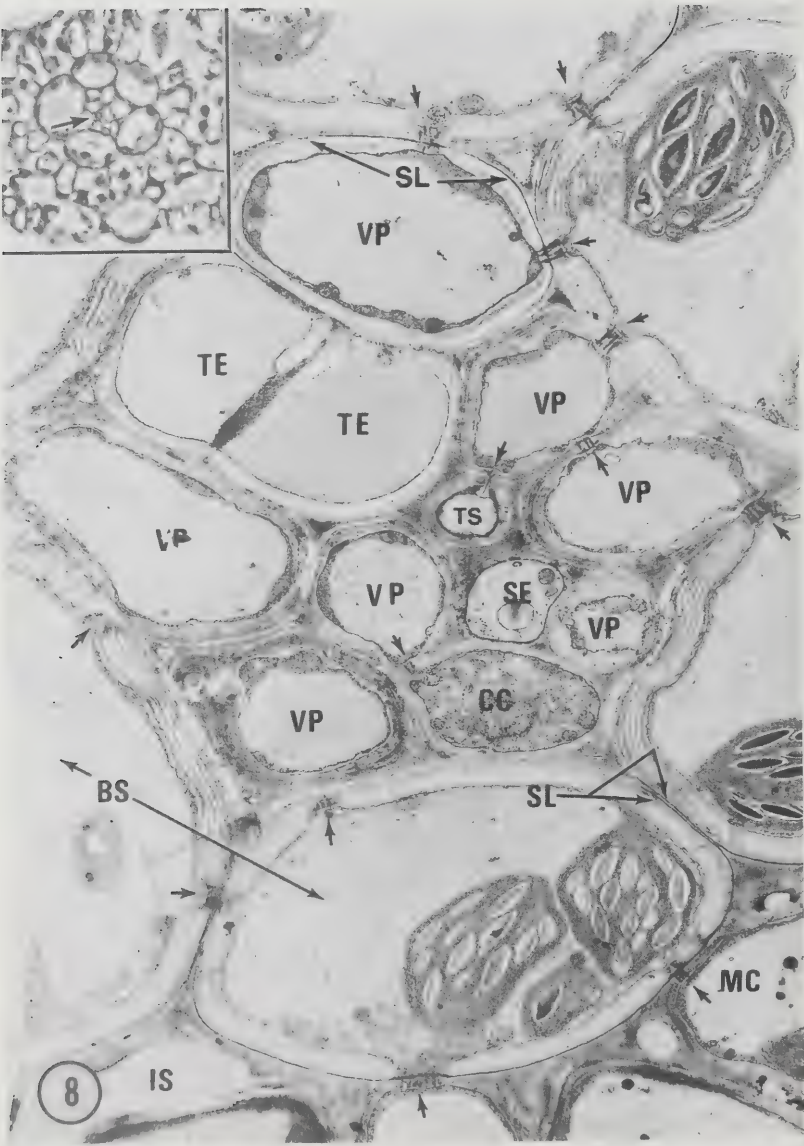
It is the small bundles, consisting entirely of metaxylem and metaphloem, that are completely encircled by chlorenchymatous bundle sheaths and mesophyll cells that radiate out from the sheaths. Transverse views of small bundles from the three provenances are illustrated in Figures 1 and 2 (TFR), 4 (TA), and 6 and 8 (TH); and in longitudinal view in Figures 9–11 (TFR, TA, and TH, respectively).

FIG. 6.

Phase-contrast micrograph of part of mature leaf blade of *Themeda* (Hogsback), showing intermediate (left) and small (right) vascular bundles. Both bundles are surrounded by a chlorenchymatous bundle sheath (BS), and both contain thick-walled sieve tubes (unlabelled arrows) next to the xylem. The intermediate bundle is associated with sclerenchyma girders (SG) both ad-and abaxially. IS = intercellular space. X 700.

FIG. 7.

Electron micrograph showing portions of bundle-sheath cells (BS) and adjacent mesophyll cell (MC) in *Themeda* (Hogsback). The agranal chloroplasts of the bundle-sheath cells contain numerous starch grains. Arrowheads point to plasmodesmata in walls between bundle-sheath cells and between a bundle-sheath cell and mesophyll cell. IS = intercellular space. 6% glutaraldehyde, 2% OsO<sub>4</sub> in 0.05 M cacodylate buffer. X 8650.



As with intermediate bundles, except for the companion cells, all of the parenchymatous cells of the small bundles are referred to as vascular parenchyma cells. All small bundles apparently contain at least one thick-walled sieve tube and one thin-walled sieve tube. Commonly, the thick-walled sieve tubes are in direct contact with tracheary elements.

### 3.3. The Bundle-sheath Cells

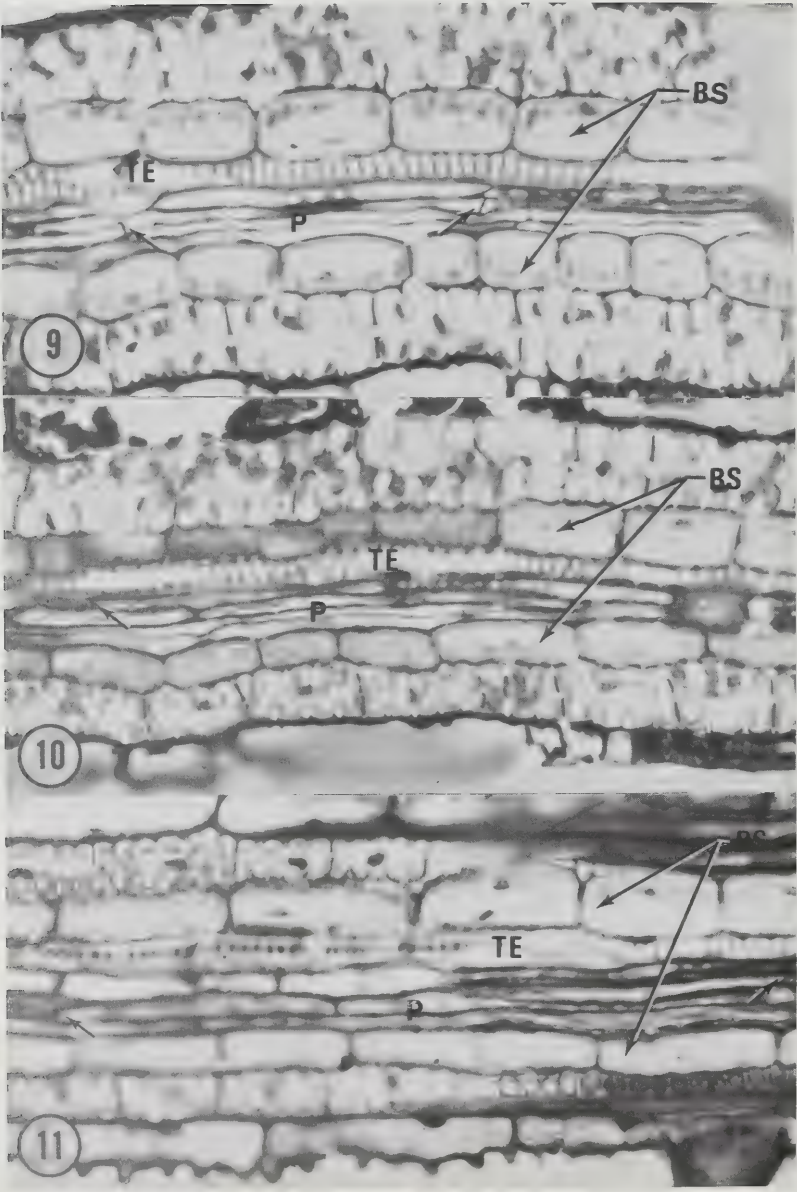
The walls of the bundle-sheath cells in all provenances are appreciably thicker than those of contiguous mesophyll cells (Figs 3, 5, and 7). In addition, all of the bundle-sheath cell walls have a more or less lamellate appearance, with those of TH being most conspicuously lamellate (Figs 7 and 8) and those of TFR being least so (Fig. 3). The lamellate appearance in TH material post-fixed in osmium tetroxide is so conspicuous that it can be used as a reliable criterion at the electron-microscope level to distinguish TH from TFR or TA material. Examination of both fresh, free-hand sections and thinner, freeze-microtomed sections treated with phloroglucinol-HCl, indicate that the electron-opaque portions of the walls correspond to more heavily lignified regions.

When viewed in transverse sections, the outer tangential and radial walls of all bundle-sheath cells exhibit a continuous suberin lamella. The suberin lamella is conspicuously wider in the regions of the wall between bundle-sheath cells or bundle-sheath cells and mesophyll cells transversed by aggregates of plasmodesmata (Figs 3, 5, 7, 8). The plasmodesmata are aggregated in the pit-membranes of the bundle-sheath cell walls. Two suberin lamellae occur in the radial walls between adjacent sheath cells, one on either side of the compound middle lamella (Figs 3 and 8).

Suberin lamellae also occur in the outer tangential and radial walls of cells that fill the gaps in the chlorenchymatous bundle sheaths resulting from the presence of sclerenchyma girders. In addition, the outer tangential and radial walls of vascular parenchyma cells bordering tracheary elements may be suberised (Fig. 8).

FIG. 8.

Electron micrograph showing small vascular bundle and portions of contiguous tissues in leaf blade of *Themeda* (Hogsback). In this plane of section, the vascular bundle is surrounded by six chlorenchymatous bundle-sheath cells (BS). The walls of the bundle-sheath cells have a distinct lamellate appearance. The bundle contains two tracheary elements (TE) and two sieve tubes. The sieve tube bordering the tracheary elements is a thick-walled type (TS), and the one bordering the companion cell (CC) a thin-walled type (SE). MC = mesophyll cell; IS = intercellular space; SL = suberin lamella; VP = vascular parenchyma cell. 6 % glutaraldehyde, 2 % OsO<sub>4</sub>, 0.05 M cacodylate buffer. X 6100. Inset: Phase contrast micrograph of similar sized bundle. Unlabelled arrow points to thick-walled sieve tube. X 470.



The chloroplasts of the bundle-sheath cells are commonly centrifugally arranged. They are agranal and commonly contain numerous starch grains (Figs 3, 5, 7 and 8).

### 3.4. *The Mesophyll*

As seen in transverse sections, most of the mesophyll cells—the Kranz mesophyll cells—are in direct contact with and radially arranged around the chlorenchymatic bundle sheaths. In this view, the mesophyll cells appear “palisade-like” (e.g. Fig. 4); however, in longitudinal sections (Figs 9–11) they can be seen to be deeply lobed or branched.

During examination of transverse sections, the impression was gained that the laminae of *T. Alice* and *T. Hogsback* contained a greater volume of intercellular space than those of *T. Fish River*. In order to confirm this impression, the percentage volume of intercellular space was determined in samples of fresh lamina material from the three provenances. The results of those experiments substantiate the anatomical observations. TFR contained the lowest percentage air volume (3.78 %) and TH the greatest (6.68 %), with TA (6.06 %) close behind TH. The variance was such that no overlap existed between provenances.

## 4. DISCUSSION

As is typical of the Poaceae, the longitudinal vascular bundles in the leaf blades of *Themeda triandra* can be divided, for descriptive purposes, into three orders, or groups, according to size and structure (Ellis, 1976). The criteria used to distinguish among orders during the present study are essentially the same as those used in light microscope studies: first order (large) bundles are distinguished by the presence of large metaxylem vessels and protoxylem, and an association with hypodermal sclerenchyma girders; second order (intermediate) bundles by the absence of large metaxylem vessels and protoxylem and an association with hypodermal sclerenchyma strands and/or girders; third order (small) bundles by the absence of large metaxylem vessels and protoxylem, and of hypodermal sclerenchyma. In addition, small bundles often are described as having indistinguishable xylem and phloem elements at the light microscope level (Metcalf, 1960; Ellis, 1976),

FIGS. 9–11.

Longitudinal sections showing portions of small vascular bundles of *Themeda triandra* Fish River (Fig. 9), Alice (Fig. 10), and Hogsback (Fig. 11) provenances. Note the deeply lobed mesophyll cells bordering the bundle sheaths (BS) both ad- and abaxially. P = phloem; TE = tracheary element; unlabelled arrows point to sieve plates or thick-walled sieve tubes bordering xylem. Toluidine blue. All X 680.



It is pertinent to note that the so-called orders or sizes of bundles intergrade with one another, and that many intermediate forms exist. Little is known about the spatial, developmental, or functional relationships of the various sized bundles in grass leaves. This problem merits detailed study.

*T. triandra* represents the second  $C_4$  grass species known to have both thick- and thin-walled sieve tubes in the phloem of its leaf blade bundles. Both types of sieve tube also occur in the leaf blades of *Zea mays*, but apparently in only the small and intermediate bundles (Evert, Eschrich and Heyser, 1978). In *T. triandra*, all three bundle orders have both sieve-tube types; whether the median bundles also have both types remains to be determined. Thick- and thin-walled sieve tubes have been recorded in the longitudinal bundles of the leaf blades of two  $C_3$  grasses, *Triticum aestivum* (Kuo and O'Brien, 1974) and *Oryza sativa* (Miyake and Maeda, 1976). The significance or role of the thick-walled sieve tubes remains to be determined (Evert, 1980).

The leaf blade anatomy of *T. triandra* is typical of that of other Andropogoneae: vascular bundles surrounded by a single layer of bundle-sheath cells with centrifugally-arranged, agranal chloroplasts (Carolin, Jacobs and Vesk, 1973). Moreover, on the basis of its anatomy, *T. triandra* has been classified as a XyMS-  $C_4$  species; that is, a species in which cells are absent between the metaxylem vessels and the laterally adjacent chlorenchymatous bundle sheath in at least some of the primary bundles of the blade (Hattersley and Watson, 1976). Significantly, Hattersley and Watson (1976) found a perfect correlation between NADP-malic enzyme type species and the XyMS character. All were XyMS-.

The chlorenchymatous bundle sheath of panicoid grasses long has been considered to be parenchymatous in nature and homologous to the outer sheath of festucoid grasses (Metcalf, 1960). Recently, Brown (1975) has suggested that, in at least some species of  $C_4$  grasses, the chlorenchymatous bundle sheath, which he refers to as the Kranz sheath, has evolved from a mestome sheath. He now recognises two subtypes of Kranz anatomy in grasses, the M.S. subtype in which the Kranz sheath presumably has evolved from a mestome sheath, and the P.S. subtype in which the Kranz sheath has evolved from a parenchyma sheath (Brown, 1977). Brown (1977) further assumes that all species having M.S. anatomy are NADP-malic enzyme species. *Themeda*, and apparently all of Hattersley and Watson's (1976) XyMS-species, are included among the M.S. subtype. Ellis (1977) has adopted Brown's scheme and, specifically, has assigned *T. triandra* to the Kranz mestome sheath subtype.

During the present study, the descriptive term "chlorenchymatous bundle sheath" was used to refer to the sheaths of the various bundle orders in *T. triandra*. This was done because we feel more ontogenetic and phylogene-

tic evidence is needed before the sheaths in andropogonoid grasses are designated mestome sheaths.

Although the term "Kranz" is used by many present-day workers exclusively in connection with bundle-sheath cells, Haberlandt (1882) originally used the term to describe both the chlorenchymatous bundle sheaths and the mesophyll cells radially arranged around them. Later, Haberlandt (1924) used the term to refer only to the mesophyll cells. In our opinion, the designation Kranz anatomy should include both the Kranz mesophyll and the chlorenchymatous bundle sheath, and Kranz syndrome the collection of anatomical, biochemical, and physiological features related to  $C_4$  photosynthesis.

In their presence of a continuous suberin lamella in outer tangential and radial walls, the bundle-sheath cells in *T. triandra* are similar to those of *Zea mays*, another NADP-malic enzyme species (Evert, Eschrich and Heyser, 1977). Unlike the bundle-sheath cells in *Zea mays*, however, the inner tangential walls of those in *T. triandra* are not suberised at the sites of plasmodesmatal aggregates. Suberin lamellae also occur in the mestome sheath walls of  $C_3$  grasses (O'Brien and Carr, 1970; Carolin, Jacobs and Veski, 1973). In addition to being suberised, the bundle-sheath cell walls in *T. triandra* are lignified, a condition not uncommon in grasses.

Except for the marked difference in percentage volume of intercellular space between the leaf blades of *T. Fish River* and those of *T. Alice* and *T. Hogsback*, no anatomical differences could be discerned among the provenances that might give one a special adaptive advantage over the other. One of the most common characteristics of xeromorphic leaves, however, is a small intercellular-space volume (Esau, 1977). In this respect, *T. Fish River*, with its relatively low volume of intercellular space might be better adapted for growth in the hot, semi-arid Fish River Valley area than the other two provenances.

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## STUDIES IN THE GENERA OF THE *DIOSMEAE* (RUTACEAE): 14. A REVIEW OF THE GENUS *DIOSMA* L.

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### ABSTRACT

Twenty-eight species belonging to the genus *Diosma* L. are listed with diagnoses and keys. Species not recently published are described in detail from fresh material with current distribution maps and lists of specimens examined. Two new species, *D. parvula* and *D. tenella* are described and a new name, *D. fallax*, has been substituted for *D. eckloniana*.

### UITTREKSEL

STUDIES IN DIE GENERA VAN DIE *DIOSMEAE* (RUTACEAE): 14.  
'N OORSIG VAN DIE GENUS *DIOSMA* L.

Die ag-en-twintig soorte van die geslag *Diosma* L., met diagnose en sleutels, word gekatalogiseer. Soorte nie onlangs gepubliseer nie word van vars materiaal beskryf. Twee nuwe *Diosma* soorte, *D. parvula* en *D. tenella* word beskryf en die naam *D. eckloniana* word vervang deur *D. fallax*.

### HISTORICAL BACKGROUND

The name *Diosma*, proposed by Linnaeus in the first edition of his *Genera Plantarum* published in Leiden in 1737, is derived from "dio" meaning of the sky and "-osma" meaning scent or, in other words, the heavenly scent. At that time Linnaeus observed that the fruit in scent and shape resembled that of *Anisum stellatum*. With the publication of Linnaeus's *Species Plantarum* in 1753 the nomenclatural validity of the generic name *Diosma* was confirmed. The discovery in Southern Africa of many new species meant that by the end of the next seventy years about a dozen new genera in the Rutaceae (*Diosmeae*) had been proposed. Of these, two, *Barreira* and *Hartogia* proposed by Linnaeus had been transferred to *Diosma* by Linnaeus himself in 1771 and then in 1824, when De Candolle published the first part of his *Prodromus*, he transferred nearly all the remaining new genera to *Diosma*. In the same year Bartling & Wendland in revising the *Diosmeae* maintained some of these genera and proposed several new generic names.

These proposals were not however universally acclaimed and in 1839 D. N. F. Dietrich in his *Synopsis Plantarum* transferred all these genera back into *Diosma* making many new combinations in the process. In this he was echoed by Steudel (1841) in his *Nomenclator Botanicus*.

In a revision of the Rutaceae for the *Flora Capensis* (1860), Sonder saw fit to completely disregard De Candolle, Dietrich and Steudel and to uphold the work done by Bartling & Wendland. Their more restricted concept of the genus *Diosma* has been followed by the present author and the very long list appended to this review, containing 164 excluded species, bears witness to the controversy which existed more than 120 years ago.

#### DISTRIBUTION

The twenty-eight species comprising the genus *Diosma* are found in the south and south western Cape Province in an area extending from the Cockscomb mountain and from near Humansdorp in the east to the Cape Peninsula in the west and from Cape Agulhas in the south to near Nieuwoudtville in the north, with outliers in Little Namaqualand near Garies and in the vicinity of Springbok. As far as is known these outlying populations, consisting of only two species, *D. acmaeophylla* and *D. ramosissima*, are unique in

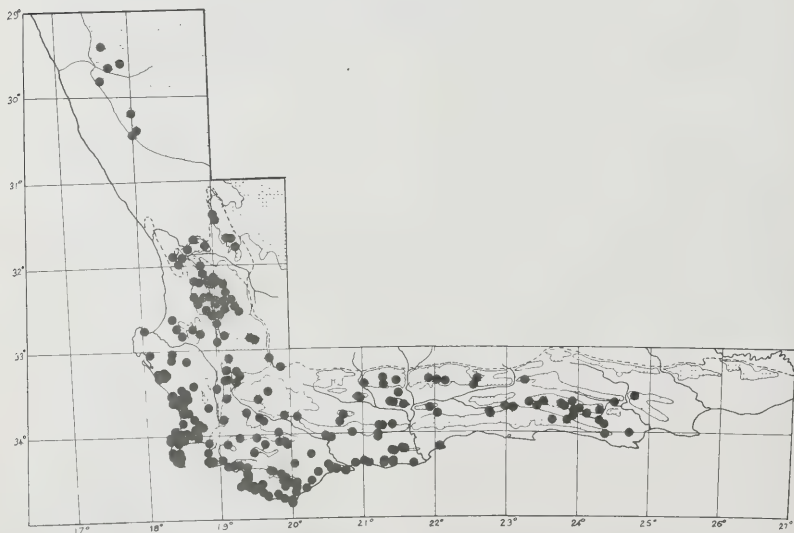


FIG. 1.  
Distribution of the genus *Diosma*.



that with the exception of the species *Agathosma namaquensis* Pillans all other species in the various genera of the *Diosmeae* are unrepresented to the north of Nieuwoudtville.

Within the main area of distribution, populations appear to be particularly concentrated fairly near to the coast from the Gouritz River Mouth around the Cape to Mamre.

Another area showing a smaller concentration of species is to be found in the Clanwilliam Division and a somewhat outlying group of species is to be found in the Langkloof and Baviaanskloof areas in the extreme east.

The distribution map, Figure 1, shows the actual collection localities of all specimens observed in all species in the genus with the exception of *Diosma hirsuta* where only one collection has been shown in each quarter degree square in which the species is known to occur.

#### MATERIAL CITED

All specimens cited in this paper, including types, have been examined by the author.

#### GENERIC DESCRIPTION

**Diosma** L. Sp. Pl. 1: 198 (1753); Gen. Pl.: 60 (1737); Roy., Flor. Leyd. Prodr.: 435 (1740); Berg., Plant. Cap.: 62 (1767); Juss., Gen. Plant.: 298 (1789); Engl., Gen. Plant. 6017: 1157 (1840); Sond. in Flor. Cap. 1: 373 (1860); Dyer, Gen. S.Afr. Flow. Plant. 1: 291 (1975). Type species: *D. hirsuta* L.

*Shrubs* woody, from less than 0.2 m tall, low and spreading to 3 m tall, erect, normally arising from a single stem at base. *Branches* glabrous or glabrescent, devoid of leaves, usually erect. *Branchlets* erect, slender, short, glabrous or minutely puberulous, leafy, sometimes clustered. *Leaves* 1.5–26 mm long, 0.7–4 mm broad, simple, alternate or less usually opposite, linear, linear-lanceolate, lanceolate, subulate, ovate, elliptic or oblong, acute with a sharp point or mucronate or obtuse, sessile or short-petiolate, eciliate or ciliate or crisped-ciliate, gland-dotted, glabrous or pubescent. *Inflorescence* terminal; *flowers* up to 10 mm diam., usually much less, short-pedicellate or sessile, solitary or up to 4-nate or crowded up to 12 together, borne on short branchlets or in much reduced compound racemes. *Bract* one per flower, often resembling a reduced leaf. *Bracteoles* two, usually very much reduced. *Calyx lobes* five, small, persisting, deltoid or broadly lanceolate or ovate, acute or obtuse, usually minutely ciliate below with translucent margins. *Petals* five, white or cream or slightly reddened, orbicular, oblong, elliptic, ovate or broadly lanceolate, sessile or sometimes sub-sessile, connate with the lobes of the disc, glabrous or puberulous or in one case with up to seven

long hairs, usually sparsely ciliate below, spreading except in one case where delapsing when in bud. *Staminodes* absent or seen as a vestigial gland on the outer edge of the lobes of the disc. *Filaments* five, 1–2 mm long, acicular, glabrous except in one case with a few minute hairs. *Anthers* five, 0.5–1.4 mm long, 0.5–1.1 mm broad, bi-locular, splitting lengthwise, dorsifixed; apical gland sessile except in *D. dichotoma* where the apex tapers to a recurved gland and *D. thyrsophora* where the gland is inflexed. *Pollen* 43–66  $\mu$  long, 22–35  $\mu$  broad, oblong, triporate. *Disc* well developed, sinuate-crenulate, 5-lobed, fleshy, nectariferous, standing open, exceeding the ovary by a long way. *Stigma* capitellate, 0.15–0.3 mm diam. *Style* 0.5–2 mm long, usually at some stage deflexed, glabrous except in *D. strumosa* where very sparsely and minutely pubescent. *Ovary* 5-carpellate, 0.5–1 mm long, 0.5–1.2 mm diam., usually glabrous, or sometimes with the apices fringed with a few hairs or in one case echinulate, often glandular with the gland persisting and immersed at the apex of the horn of the ripe fruit. *Fruit* 5-carpellate; carpels glabrous or rarely puberulous, striate-veined, pitted with gland dots or rarely with warty swellings; horns erect or spreading, long or short. *Seed* 3.5–7.7 mm long, 1.6–3 mm broad, black, shining except in *D. acmaeophylla*, *D. ramosissima* and *D. meyeriana* where matt and in *D. tenella* where striate.

#### DIAGNOSTIC CHARACTERS

Characters which distinguish the genus *Diosma* are: flowers less than 10 mm diam, with petals spreading, with the disc conspicuous, sinuate-crenulate, overtopping the ovary, without staminodes or with the staminodes vestigial, with the style and filaments very short not exceeding the petals and the ovary 5-carpellate. It differs from *Adenandra* which has anthers with a stipitate gland, from *Acmadenia*, *Agathosma* and *Coleonema* which have terete, acicular or petaloid staminodes, from *Euchaetis* which has transversely bearded petals, from *Macrostylis* and *Phyllosma* which have very long styles and filaments, from *Sheilanthera* which has the petals clawed and from *Empleurum* which has the ovary normally unilocular.

#### ARRANGEMENT OF SECTIONS

The genus may be conveniently divided into two sections:

1. *Diosma* section *Diosma* which is distinguished by having flowers without staminodes (species no's. 1–15).
2. *Diosma* section *Tumella* which is distinguished by having flowers with vestigial staminodes (species no's. 16–28).

KEY TO THE SPECIES OF *DIOSMA*

- 1     Staminodes absent. (Section 1) ..... 2
- 1+   Staminodes vestigial. (Section 2) ..... 16
- 2     Leaves mostly opposite ..... 3
- 2+   Leaves alternate ..... 5
- 3     Leaves 1,5–4 mm long ..... **15. dichotoma**
- 3+   Leaves more than 5 mm long ..... 4
- 4     Plant many stemmed, resprouting after fires ..... **14. oppositifolia**
- 4+   Plant single stemmed at base, not resprouting after fires ..... **9. subulata**
- 5     Seed surface matt ..... 6
- 5+   Seed surface shining ..... 8
- 6     Petals glabrous ..... **3. meyeriana**
- 6+   Petals minutely pubescent ..... 7
- 7     Leaves with a sharp recurved mucro ..... **1. acmaeophylla**
- 7+   Leaves obtuse or with a small callus ..... **2. ramosissima**
- 8     Petals with from 2 to 7 long weak hairs ..... **13. pilosa**
- 8+   Petals without long weak hairs ..... 9
- 9     Flowers 2,5 mm diam., disc profusely pitted ..... **7. parvula**
- 9+   Flowers more than 3 mm diam., disc with few pits ..... 10
- 10    Leaves ovate or ovate-lanceolate ..... 11
- 10+   Leaves linear, linear-lanceolate or subulate ..... 12
- 11    Leaves ovate 3–4 mm long ..... **12. sabulosa**
- 11+   Leaves ovate-lanceolate up to 8 mm long ..... **10. awilana**
- 12    Bracts, bracteoles and calyx lobes long-crisped ciliate ..... **11. arenicola**
- 12+   Bracts, bracteoles and calyx lobes not long-crisped-ciliate ..... 13
- 13    Leaves sessile ..... **8. fallax**
- 13+   Leaves short-petiolate ..... 14
- 14    Leaves often abruptly recurved at the apex, flowers 9–10 mm diam. .... **4. aspalathoides**
- 14+   Leaves with a straight point, flowers 6–7 mm diam ..... 15
- 15    Leaves with a narrow midrib when dry, petals not persisting beneath the ripening fruit ..... **5. pedicellata**
- 15+   Leaves with a broad midrib when dry, petals persisting beneath the ripening fruit ..... **6. hirsuta**
- 16    Flowers with petals only when in bud ..... **26. apetala**
- 16+   Flowers with petals at anthesis ..... 17
- 17    Seed minutely wrinkled, not shining ..... **19. tenella**
- 17+   Seed smooth, shining ..... 18
- 18    Leaves with a sharp point ..... 19
- 18+   Leaves obtuse or mucronate with a small blunt callus ..... 20
- 19    Leaves subulate-aristate up to 19 mm long ..... **16. aristata**
- 19+   Leaves linear-lanceolate acute up to 10 mm long ..... **17. rourkei**
- 20    Leaves mucronate with a small blunt callus ..... 21
- 20+   Leaves obtuse ..... 23
- 21    Leaves opposite, sessile, glabrous ..... 22
- 21+   Leaves alternate, short-petiolate, sparsely setose on all sides ..... **22. echinulata**
- 22    Leaves 2,5–3,7 mm broad ..... **23. guthriei**
- 22+   Leaves 1,8–2,2 mm broad ..... **24. haelkraalsensis**
- 23    Leaves short petiolate ..... 24
- 23+   Leaves sessile ..... 25
- 24    Leaves recurved, petals gland-dotted ..... **20. recurva**
- 24+   Leaves straight, petals without gland dots ..... **25. demissa**
- 25    Leaves linear-lanceolate, branchlets crowded ..... **18. thyrsoptera**

25+	Leaves oblong, elliptic or lanceolate-obtuse .....	26
26	Leaves oblong, midrib lumpy with gland dots .....	21. <b>prama</b>
26+	Leaves elliptic or lanceolate-obtuse .....	27
27	Leaves elliptic, style and filaments glabrous .....	27. <b>passerinoides</b>
27+	Leaves lanceolate-obtuse, style and filaments very sparsely pubescent .....	28. <b>strumosa</b>

# 1. DIOSMA sectio DIOSMA

Section *Diosma* is distinguished in having the flower without staminodes.

1. *D. acmaeophylla*
2. *D. ramosissima*
3. *D. meyeriana*
4. *D. aspalathoides*
5. *D. pedicellata*
6. *D. hirsuta*
7. *D. parvula*
8. *D. fallax*
9. *D. subulata*
10. *D. awilana*
11. *D. arenicola*
12. *D. sabulosa*
13. *D. pilosa*
14. *D. oppositifolia*
15. *D. dichotoma*

**1. *Diosma acmaeophylla*** Eckl. & Zeyh., Enum. Plant.: 108 (1835). Type: In solo arenoso (altit. II, III) laterum montium prope Brakfontein (Clanwilliam), Jul, Eckl. & Zeyh. 849 (K, lectotype; C, G, LD, P, PRE, S, SAM, isotypes).

*Shrubs* 0,5–2,5 m tall, erect, arising from a single stem towards the base, a stem 45 mm diam. showed  $\pm$  20 growth rings. *Branches* forked, curved upwards, glabrous; bark smooth, reddish-brown, leafless. *Branchlets* slender, erect, quite short, minutely, puberulous, not hidden by the leaves. *Leaves* 5–26 mm long, 0,8–1,3 mm broad, linear, sub-terete, sessile, alternate in 5 spirals, erect; apex acute with a sharp recurved mucro; margins rounded, narrowly or not in the least translucent, eciliate or sparsely ciliate or serrulate; adaxial surface rounded, glabrous, with gland dots scattered in two or more rows. *Inflorescence* solitary, sessile, terminal on very much reduced branchlets in groups. *Bract* 1,6 mm long, 0,8 mm broad, ovate-lanceolate, acute, apiculate; margins ciliate mainly below; adaxial surface crisped pubescent; abaxial surface glabrous, gland-dotted. *Bracteoles* two, 1,1 mm long, 0,7 mm broad, ovate, acute with a very small callus at the apex, ciliate, adaxially pubescent, abaxially sparsely pubescent to either side of the midrib. *Calyx lobes* five, 1,4 mm long, 1,2 mm broad, ovate,

apiculate, ciliolate, pubescent on both surfaces, gland-dotted, margins broadly translucent. *Petals* five, 2.5 mm long, 1.9 mm broad, sub-orbicular, sparsely ciliolate-serrulate above, abaxially puberulous above, pure white. *Staminodes* none. *Filaments* five, becoming 1.5 mm long, acicular, glabrous. *Anthers* before anthesis 1.1 mm long, 0.7 mm broad, yellow; apical gland globose, sessile, translucent. *Pollen* 61  $\mu$  long, 30  $\mu$  diam., oblong. *Disc* 5-sinuate-crenulate, bright green, exceeds the ovary by a long way, stands open, exudes nectar. *Stigma* 0.3 mm diam., capitellate, green. *Style* at first deflexed becoming 1.5 mm long, glabrous. *Ovary* 5-carpellate, 0.6 mm long, 0.8 mm diam., glabrous, apices globose. *Fruit* 5-carpellate, 8–11.5 mm long, glabrous, 1–2 mm pedicellate above the calyx; *horns* 2–6 mm long, projecting at 45° with an immersed gland at the apex. *Seed* 7.3–7.7 mm long overall, 2.6–2.9 mm broad, black, matt; aril black and white streaked.

This rather distinctive species with sessile, linear leaves was collected by Zeyher in the year 1829 near Brakfontein which lies 12 km north of where Citrusdal now stands. Having the apex of the leaf recurved with a sharp point must have led Sonder to consider it to be conspecific with *Diosma aspalathoides* Lam. and so it has remained in synonymy for over one hundred years. In herbaria it was also confused with *Diosma hirsuta* L. under the name *Diosma vulgaris* Schldl. The above description prepared from fresh material amplifies the very good diagnosis previously given by Ecklon and Zeyher.

#### SPECIMENS EXAMINED

- CAPE—2917 (Springbok): Spektakelberg, 2 miles S. of Naries (-DA), 9/9/1970, *Thompson 1032* (PRE); Little Namaqualand, Buffels River, 6/9/1945, *Leighton 1191* (BOL); Komaggas Mountains (-DC), 700 m, -/7/1926, *Meyer s.n.* (PRE-Marloth 6955).
- 3017 (Hondeklipbaai): Namaqualand, 3 miles E. of Kamieskroon (-BB), 3 500 ft., 24/9/1948, *Acocks 14989* (PRE); Bowiesdorp, -/9/1941, *Stokoe 8175* (BOL); Sneeuwkop, Khamiesberg, 14/10/1928, *Hutchinson 865* (BOL); Brakdam, Little Namaqualand (-BD), 24/8/1941, *Esterhuysen 5684* (BOL).
- 3018 (Kamiesberg): 3 miles S.E. of Leliefontein (-AC), 4 300 ft., 24/3/1948, *Acocks 14206* (PRE); Kasparskloof, 3–4 000 ft., -/8/-, *Drège 7135* (S); Kamiesbergen, Garies/Leliefontein, top of pass, -/11/1939, *Esterhuysen 1400* (BOL, PRE); Koornslandskloof, 25 miles N.E. of Garies, 4 000 ft., 14/8/1967, v.d. Westhuizen 1 ✓ (PRE), *van Breda 4056* (PRE).
- 3118 (Vanrhynsdorp): 21 miles S.S.W. of Vredendal, Vanrhynsdorp Division (-DC), 500 ft., 26/8/1958, *Acocks 19709* (PRE); Klaver, 29/10/1944, *Leipoldt 4112* (BOL), 1/8/1920, *Andrae 499* (PRE); Pass above Trawal, 1 100 ft., 21/8/1976, *Williams 2191* (NBG); The Waterfall, S. end of Matsikamma Mountains (-DD), 1 100 ft., 20/8/1976, *Williams 2190* (NBG); Matsikamma plateau, top of Katberg Pass, 11/8/1976, *Goldblatt 3848* (MO).
- 3119 (Calvinia): Van Rhyns Pass (-AC), 2 200 ft., 23/8/1972, *Williams 1677* (NBG), ✓ (PRE); Lokenberg (-CA), 2 100 ft., 18/9/1955, *Leistner 342* (PRE), 29/8/1953, *Acocks*



17053 (PRE), 1/8/1953, *Acocks 16876* (PRE), 28/8/1958, *Acocks 19716* (BOL, PRE); Botterkloof Pass (-CD), 2 500 ft., 20/8/1976, *Williams 2189* (NBG), 31/3/1973, *Taylor 8388* (PRE), 24/9/1952, *Maguire 1900* (NBG).

—3218 (Clanwilliam): Zeekoevlei (-BA), -/7/1941, *Esterhuysen 5616* (BOL, PRE); Langkloof in saxosis (-BB), 800 ft., 5/7/1896, *Schlechter 8036* (BM, BOL, G, GRA, P, PRE, S); Boschkloof, III, A, d, 1, 1 500–2 000 ft., 26/11/1828, *Drège 1890* (P, PRE); Pakhuis Pass, farm Kleinkliphuis, 31/10/1963, *Schlieber and van Breda 9904* (PRE), -/3/1964, *Hardy 1721* (PRE); 1 km S. of Swartbaskraal (-BC), 800 ft., 14/8/1973, *Williams 1848* (NBG, PRE, S, STE); Sandveld between Greys Pass and Graafwater, -/8/1940, *Leipoldt 3353* (BOL); Paliesheuwel (-BD), 10/9/1950, *Maguire 425* (BOL); N. boundary of Bergvalley, Paliesheuwel, 1 100 ft., 11/7/1975, *Williams 2009* (NBG); N. slope of Schimmelberg, 12/10/1939, *Pillans 9115* (BOL); 0.9 m from St Helena Bay to Slipper Bay (-CA), 400 ft., 14/6/1967, *Thompson 282* (PRE), 200 ft., 11/8/1977, *Williams 2329* (NBG); Pickenierskloof (-DB), 1 300 ft., 26/6/1896, *Schlechter 7944* (BM, BOL, G, GRA, S), 1 100 ft., 23/8/1894, *Schlechter 4961* (BOL, GRA); Greys Pass, 5/10/1952, *Esterhuysen 20592* (BOL).

—3219 (Wupperthal): Boentjiesrivier in arenosis (-AA), 2 600 ft., 25/8/1896, *Schlechter 8677* (G, PRE); Heuningvlei/Boontjieskraal, 31/11/1941, *Esterhuysen 7521* (BOL, GRA, PRE, SAM); Pakhuis Pass, Clanwilliam Division, 28/12/1941, *Esterhuysen 7388* (BOL, PRE, GRA), 9/2/1941, *Leipoldt 3657* (PRE), 3 500 ft., -/12/1940, *Leipoldt 3345* (PRE), 3 000 ft., 30/9/1940, *Compton 9596 on L.H.S.* (PRE), 28/9/1940, *Esterhuysen 3144* (BOL, PRE), 28/9/1940, *Esterhuysen 3145* (PRE), 3 000 ft., 28/12/1948, *Esterhuysen 14984* (BOL), 28/9/1940, *Esterhuysen 3145, 3146, 3147* (BOL), -/12/1940, *Esterhuysen 3345* (BOL), 2 500–3 000 ft., 16/1/1953, *Esterhuysen 21148* (BOL, PRE); Pakhuis/Heuningvlei, 28/12/1941, *Esterhuysen 7388* (PRE), 7434, 7743 (BOL); In solo arenoso (altit. II, III) laterum montium prope Brakfontein, Clanwilliam (-AC), Jul., *Ecklon & Zeyher 849* (C, G, K, LD, P, PRE, S, SAM); Cedarberg, Crystal Pool, 4 300 ft., 14/2/1973, *Williams 1762* (NBG, PRE); Wupperthal, -/7/1916, *Marloth 7147* (PRE), *Drège 7133* (S), -/11/1929, *Thode 1971* (PRE); Uitkyk Pass, Cedarberg, 2 000 ft., 7/7/1935, *Compton 5332* (BOL); Sederhoutkloof, 3 000–4 000 ft., 3/9/1963, *Taylor 5120* (PRE); S. Cedarberg, Sneeuwberg Hut, 4 250 ft., 1/12/1976, *Williams 2247* (NBG); Cedarberg, base of Wolfberg (-AD), -/3/1940, *Esterhuysen 2516* (BOL, PRE); Citrusdal, Donderhoek Peak (-CA), to 6 000 ft., -/1/1944, *Stokoe 9418* (PRE); Kromrivier (-CB), 3 350 ft., 18/9/1975, *Williams 2086* (NBG), 4/10/1952, *Esterhuysen 20559* (BOL), -/9/1934, *Leighton s.n.* (BOL 21585); Zoon Ridge, Suurvlakte, E. Cold Bokkeveld, Ceres Division (-CD), 3 500 ft., 18/9/1964, *Taylor 5906* (PRE); Rocky ridge on farm Suurvlakte above Winkelhaaks River (-DC), 20/4/1946, *Esterhuysen 12705* (BOL); near Winkelhaaks River on road to Swartruggens, 18/11/1961, *Esterhuysen 29302* (BOL, PRE).

—3319 (Worcester): Ceres Karroo, Spes Bona at foot of Swartruggens (-BA), 23/10/1922, *Marloth 9091* (PRE); Ceres Karroo, Vaalkloof, N. slope of Bontebergen (-BB), 1 000 m, -/8/1919, *Marloth 9091* (PRE).

—3320 (Montagu): Matjiesfontein, Witteberg (-BC), 1 050 m, -/7/1903, *Marloth 2962* (PRE), 21/6/1908, *Pearson 1584* (PRE), 3 000 ft., 11/8/1924, *Compton 2526* (BOL), 1/5/1941 *Esterhuysen 5163* (BOL, PRE), 24/10/1943, *Leighton 259* (BOL, PRE), 11/5/1941, *Walgate 250* (NBG).

#### DISTRIBUTION AND VARIATION

*Diosma acmaeophylla* is found growing in dry situations in sandy quartzitic soil derived from granite or from the Table Mountain geological series at altitudes varying from 120 to 1 300 m (400–4 300 ft.) above sea level. The

main concentration is within a radius of about 60 km of Clanwilliam. Outliers occur in Namaqualand far to the north, at St Helena Bay to the south west and at Matjiesfontein to the south east.

There appears to be a considerable degree of variation in the size of the leaves. This may be to some extent related to the age of the plant, the oldest plants having the smallest leaves. The leaves of plants from most populations are extremely glabrous and have thick eciliate margins. However, those from the Waterfall near Vanrhynsdorp (Williams 2190) are thinly puberulous on all sides and those from the Witteberg near Matjiesfontein (Walgate 250) and from Van Rhyns Pass (Williams 1677) are ciliate. It was

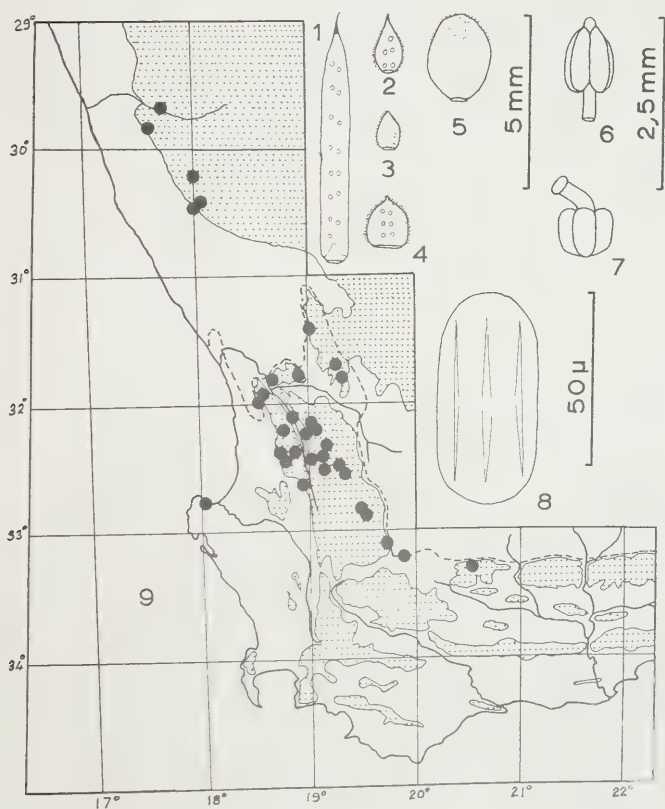


FIG. 2.

*Diosma acmaeophylla*: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, anther. 7, gynoecium. 8, pollen. 9, distribution.

also noted that the leaves of plants from Swartbaskraal (Williams 1848) had a pleasant sweet smell rather like *Coleonema album* when crushed and that those from the Cedarberg near Krom River (Williams 2088) had a strong smell of camphor.

*Diosma acmaeophylla* is regarded as a distinct species being a tall shrub, single-stemmed at base with leaves sessile, pubescent and flat on the adaxial surface, apex with a thin sharp mucro, margins thick and with petals pubescent outside towards the apex. It differs from *D. hirsuta* L., *D. aspalathoides* Lam. and *D. pedicellata* Williams which have glabrous leaves and petals.

**2. *Diosma ramosissima*** Bartl. & Wendl. *Diosmeae* in Beitr. Bot. 1: 48 (1824) excl. syns. Type: ad Cap. b. Spei, leg. Hesse, acc. 1823 (GOET, lectotype; C, GOET-WENDL, LD, P-JUSS, S, isotypes).

*Diosma flavescens* Oliv. in Hook Ic. Pl. t.1467 (1885).

Type: CAPE—3319 (Worcester): ad pedes montium prope Ceres (-AD), 24/3/1883, H. Bolus 5317 (BOL, G, GRA, P, SAM).

Icon: *D. flavescens* Oliv. loc. cit.

*Shrubs* to 1,5 m tall with many branches arising from near the base. *Branches* spreading-erect, often ternate, with a smooth brown bark. *Branchlets* numerous, slender, erect, short, minutely puberulous, leafy. *Leaves* 1,8–5 mm long, 0,7–1 mm broad, linear, straight, obtuse, sub-terete, adpressed-erect, alternate; apex somewhat callused, very short—pubescent; margins obscure; abaxial surface rounded with two rows of gland dots. *Inflorescence* terminal solitary or twin, sessile, white. *Bract* 0,9 mm long, 0,7 mm broad, sub-deltoid; apex obtuse with a small pubescent callus; adaxial surface somewhat adpressed pubescent; abaxial surface gland-dotted, puberulous towards the margins. *Bracteoles* two, 0,7 mm long, 0,5 mm broad, sub-ovate, gland-dotted, puberulous. *Calyx* sparsely puberulous. *Calyx lobes* five, 1,3 mm long, 1,2 mm broad, deltoid; margins crisped ciliolate, translucent below; adaxial surface velvety pubescent; abaxial surface gland-dotted, sparsely puberulous. *Petals* five, 2,2 mm long, 1,3 mm broad, elliptic, obtuse, arising on a lobe of the disc; margins minutely serrulate, irregularly ciliolate above; abaxial surface sparsely puberulous mainly towards the midrib and apex. *Staminodes* none. *Filaments* five, becoming 1,5 mm long, acicular, glabrous. *Anthers* five, before anthesis 0,8 mm long, 0,6 mm broad, somewhat scabrid, yellow; apical gland 1,2 mm diam., sessile. *Pollen* 52  $\mu$  long, 23  $\mu$  broad, oblong. *Disc* 5-sinuate-crenulate, stands wide open, exceeds the ovary by a long way, green, exudes nectar. *Stigma* 0,25 mm diam., capitellate, globose, green. *Style* at first deflexed, becoming 1,5 mm long, slender, glabrous. *Ovary* 5-carpellate, 0,8 mm diam., 0,6 mm long, glabrous; apices obtuse. *Fruit* 5-carpellate, 8 mm long, glabrous, gland-dotted; *horns* 3 mm long, spreading

with an immersed gland at the apex. Seed 7 mm long, 2.5 mm broad, black, matt, somewhat bean-shaped.

Unfortunately one cannot say when or where the type material for this species was collected. We only know that the Reverend D. H. F. Hesse of Meine, Hanover in Germany arrived at the Cape in 1800, that whilst at the Cape he is said to have made a name for himself as an entomologist and botanist and that he returned to Germany with his family in 1817. [Dict. S.A. Biog. 3: 390 (1971)]. Although the type locality where Bolus collected *Diosma flavescens* has been well documented, no further collection of this species in this area has ever been made. The above description prepared from fresh material amplifies those previously given.

#### SPECIMENS EXAMINED

- CAPE—2917 (Springbok): 9.5 miles W.N.W. of Bulletrap School, Schaap River, Namaqualand (-BC), 2 000 ft., 20/9/1957, *Acocks* 19524 (BOL, PRE); in collibus prope Okiep, Namaqualand Minor (-DB), 3 000 ft., -/9/1883, *H. Bolus* 94842 (BOL).
- 3118 (Vanhynsdorp): 21 miles S.S.W. of Vredendal, Vanhynsdorp Division (-CD), c.500 ft., 26/8/1958, *Acocks* 19709 A (LD, PRE); Zandkraal, Vanhynsdorp Division (-DA), 400 ft., 17/9/1948, *Acocks* 14807 (PRE); Heerenlogementsberg, Vanhynsdorp (-DC), 1 000–2 000 ft., 13/9/1962, *Taylor* 3945 (PRE, STE), 21/7/1940, *Esterhuysen* 5546 (PRE, BOL), 10/8/1977, *Williams* 2362 (NBG); de Hangen, N. slopes of Nardouwsberg, Clanwilliam, 27/9/1969, *Esterhuysen* 32254 (BOL); Kraaibos Pass summit, Clanwilliam (-DD), 1 750 ft., 19/8/1976, *Williams* 2188 (NBG).
- 3319 (Calvinia): Lokenberg, Calvinia Division (-CA), 2 200 ft., 29/7/1956, *Acocks* 18910 (PRE).
- 3218 (Clanwilliam): sandveld along road to Graafwater, Clanwilliam Division (-BA/BB), 20/7/1941, *Esterhuysen* 5596 (BOL, NBG, PRE, SAM), 28/8/1974, *Goldblatt* 2444 (MO); 15 km from Clanwilliam on road to Lamberts Bay, 15/8/1973, *Williams* 1853 (NBG); in collibus pone Zeekoevley, Clanwilliam Division 100 ft. (?), 26/4/1897, *Schlechter* 10547 (BM, G, GRA, P, PRE, S); top of Nardouws Pass, Clanwilliam Division (-BB), -/8/1934, *Pillans* 7094 (BOL), -/9/1947, *Stokoe s.n.* (SAM 64123), -/8/1949, *Stokoe s.n.* (SAM 64126); 8.5 km from Clanwilliam on road to Lamberts Bay, 1 200 ft., 15/8/1973, *Williams* 1854 (NBG, PRE, S, STE), -/7/1948, *Lewis* 3092 (SAM), 22/8/1976, *Williams* 2194 (NBG); Pakhuis Pass, rocky slopes around Leipoldt's grave, 28/8/1974, *Goldblatt* 2453 (NBG); Olifantsrivier, Clanwilliam Division (-BD), 300 ft., 2/7/1896, *Schlechter* 7991 (BM, BOL, G, GRA, P, PRE, S, W); Ramskop, Clanwilliam, 500 ft., 10/12/1962, *Grobler* 51 (PRE), 37 (STE); along National road c. 12 km S. of Clanwilliam, 1 500 ft., 26/7/1973, *Taylor* 8521 (STE); Langkloof near Klawer vlei, Clanwilliam Division, 600 ft., 18/8/1976, *Williams* 2186 (NBG); Piquetberg (-DD), 400 ft., 24/6/1896, *Schlechter* 7900 (BOL, G, GRA, P, PRE).
- 3219 (Wupperthal): Pakhuis near Village, Clanwilliam Division (-AA), 12/9/1947, *Barker* 4686 (BOL, NBG), 4687 (BOL, NBG, STE), -/9/1949, *Lewis* 3091 (SAM), 6/9/1951, *Johnson* 251 (NBG); Suurvlaakte, E. of Bokkeveld Sneeuwkop, Ceres Division (-CD), 20/4/1946, *Esterhuysen* 12697 (PRE); Zoo Ridge, Suurvlaakte, E. of Bokkeveld, Ceres Division, 14/9/1975, *Esterhuysen* 33960a (BOL); Knolfontein, Swaruggens, Ceres Division (-DC), 4 000 ft., 26/4/1972, *Williams* 1652a (NBG).



PRE); Groenfontein, Swartruggens, Ceres Division, 4 000 ft., 20/11/1974, *Williams 1931* (NBG, PRE); Swartruggens, Ceres Division, c. 4 000 ft., 19/11/1961, *Esterhuysen 29348* (BOL); Stompiesfontein, Swartruggens, Ceres Division, 18/11/1961, *Esterhuysen 29306* (BOL), 3 500 ft., 18/11/1961, *Esterhuysen 29329* (BOL); Rietvlei, Cold Bokkeveld, at the cottages, Ceres Division, 27/9/1978, *Esterhuysen 34992* (BOL); sandy rocky slopes, *Esterhuysen 34991* (BOL).

—3319 (Worcester): ad pedes montium circa pagum Ceres (-AD), 1 500 ft., 24/3/1883, *H. Bolus 5317* (BOL-HNAA 403, G, GRA, P, SAM); in clivis montis Mostert-sberg, Tulbagh Division, c. 2 500 ft., 31/1/1892, *Schlechter 385* (GRA, P); Langkloof, Skerpenheuvel, S. of the Breede River, Worcester Division (-DC), 1 000 ft., 25/11/1980, *Williams 3102* (NBG).

Without precise locality: e Cap. b. Sp. *Hesse s. n.* (C, GOET, GOET-WENDL, LD, P-JUSS, S).

#### DISTRIBUTION AND VARIATION

*Diosma ramosissima* is found growing in dry sandy or rocky places at altitudes of from about 120 m to 1 200 m (400–4 000 ft.) above sea level. Although mainly centred in the Clanwilliam Division, populations are widely dispersed from Namaqualand in the north to near the Breede River south of Worcester. The largest discontinuity is from near Okiep to near Vanrhynsdorp, a distance of about 250 km.

A certain amount of variation has been noticed. Some populations have leaves which are not obtuse but terminate in a sharp mucro. This peculiarity has not been found in one geographical area but rather inexplicably in three



FIG. 3.

Flower of *Diosma ramosissima* showing disc exuding nectar.



widely separated localities. Examples are: 21 miles S.S.N. of Vredendal, 500 ft., *Acocks* 19709, 15 mm from Clanwilliam on road to Lamberts Bay, 1 100 ft., *Williams* 1853 and Rietvlei, Cold Bokkeveld, 3 000 ft., *Esterhuysen* 33960a. The possibility of hybridisation with *D. acmaeophylla* cannot be overlooked.

*Diosma flavescens* collected once only near Ceres by H. Bolus differs only in being a more glabrous plant with relatively longer leaves. Both of these differences may be due to the plant growing in a very much more humid situation.

Specimens collected at Knolfontein in the Swartruggens (*Williams* 1652a) were found to have fruits with very short horns and leaves very short and obtuse.

*Diosma ramosissima* is a distinct species being a shrub up to 1.5 m tall with many branches spreading from near the base; with leaves linear, usually

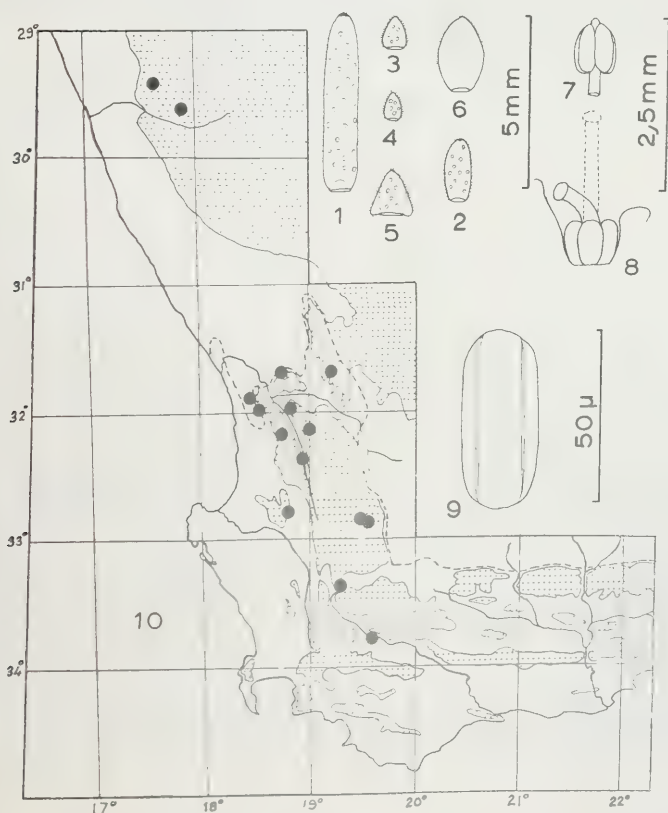


FIG. 4.

*Diosma ramosissima*: 1, large leaf. 2, small leaf. 3, bract. 4, bracteole. 5, calyx lobe. 6, petal. 7, anther. 8, gynoecium. 9, pollen. 10, distribution.

obtuse, adpressed-erect, sessile, alternate, with gland dots in rows to either side of the midrib; with flowers sessile, 1–2 nate, having petals sparsely puberulous outside towards the tip, and with a matt seed surface. It differs from *D. prama* which has leaves with gland dots scattered towards the midrib and a disc bearing vestigial staminodes. It differs from *D. dichotoma* which has opposite leaves.

**3. *Diosma meyeriana*** Spreng., Syst. Veg. 1: 783 (1825). Type: labelled: *Diosma virgata* G. F. W. Meyer. Ad Cap.b. Spei. Leg. Rev. Hesse. Comm. Cl. G. F. W. Meyer 1836 (GOET, lectotype; GOET-BARTL, P-JUSS, isotypes).

*Diosma virgata* G.F.W.Mey. ex Bartl. & Wendl. Diosmeae in Beitr. Bot. 1: 46 (1824) nom. illegit. Type: *Diosma virgata* G.F.W.Meyer, Spicil. fl. cap. Ms., Habitat in Africa maxime australi, Hesse.

Not *Diosma virgata* Lam. Encycl. Meth. Bot. 2: 286 (1786) which is *Agathosma virgata* (Lam.) Bartl. & Wendl. loc. cit.

*Shrubs* 0,4 to 1 m tall, diffuse, normally single-stemmed at base. *Branches* fairly erect, slender, quite long, glabrous, smooth, leafless, branching alternately, dark reddish-brown. *Branchlets* not very numerous, erect, straight, slender, glabrous, well clothed with leaves, reddened where exposed. *Leaves* 6–9,5 mm long, 1–1,3 mm broad, linear-lanceolate, acute, glabrous, ciliolate becoming more or less eciliate, erect, adpressed, imbricate on new shoots, sessile, alternate; apex with a straight sharp mucro; cartilaginous margins narrow with a sharp edge; adaxial surface fairly flat, concave when dry; abaxial surface rounded with two rows of gland dots. *Inflorescence* terminal, racemose-reduced; *flowers* crowded together on very short branchlets in varying numbers, opening at different times, each scarcely 4 mm diam. when open. *Bract* 1,7–2,3 mm long, 0,7–0,8 mm broad, lanceolate, acute, mucronate with a sharp point, ciliate, glabrous, adpressed, round backed, gland-dotted, cartilaginous margins fairly broad. *Bracteoles* two, 1,5 mm long, 0,7 mm broad, broadly lanceolate with a thick rib prolonged into a sharp pink mucro, glabrous,  $\pm$  1-gland-dotted, asymmetrical in outline; margins ciliate, broadly translucent. *Calyx lobes* five, 1,7 mm long, 0,6–0,8 mm broad, broadly lanceolate, glabrous; midrib gland-dotted; apex with a sharp point; margins ciliate, broadly translucent. *Petals* five, 2 mm long, 1 mm broad, oblanceolate-oblong, apiculate, sessile, white, glabrous, not spreading widely but closing up after anthesis and persisting for a long time, arising towards the summits of the lobes of the disc. *Staminodes* absent. *Filaments* five, becoming 1 mm long and spreading after anthesis, glabrous, subulate. *Anthers* five, 0,7 mm long, 0,5 mm broad, yellow; apical gland globose, minute, pale greenish. *Pollen* 45  $\mu$  long, 22  $\mu$  broad, oblong. *Disc* sinuate-crenulate, stands open, green, exceeds the ovary. *Stigma* 0,15

mm diam., capitellate. *Style* at first deflexed, later becoming erect, 0,8 mm long, glabrous. *Ovary* 5-carpellate, 0,5 mm long, 0,6 mm diam.; apices globose, green becoming reddened. *Fruit* 5-carpellate, carpels 7–9,5 mm long, pale yellowish-green, glabrous, gland-dotted, not shining; *horns* 1,5 mm long, fairly erect, reddened; apical gland immersed, facing outwards. *Seed* 4,7–5,7 mm long, 2,1 mm broad, black, matt; aril black with white streaks.

Sprengel did not agree with Bartling and Wendland who had published, in 1824 their new classification of the *Diosmeae* which they divided into several genera. Thus, in his edition of Linnaeus' *Systema Vegetabilium* published in 1825, Sprengel transferred all relevant epithets back into the genus *Diosma*. In doing so he found *D. virgata* Meyer to be a later homonym of *D. virgata* Thunberg and therefore proposed the new name, *D. meyeriana*. As the herbarium of G. F. W. Meyer housed at Berlin was destroyed during the 1939/45 war a duplicate preserved in the herbarium at Göttingen labelled *Diosma virgata* G.F.W.Meyer. *Ad Cap. b. Spei. Leg. Rev. Hesse. Comm. Cl. G. F. W. Meyer 1836* has been chosen as the lectotype. *D. meyeriana* Steud. cited by Sonder in error as a synonym of his *Coleonema juniperinum* is *D. meyeriana* Spreng.

The above description prepared from fresh material amplifies those previously given.

#### SPECIMENS EXAMINED

CAPE—3218 (Clanwilliam): about 7 miles W. of Clanwilliam on Lamberts Bay Road, Clanwilliam Division (-BB), 27/7/1948, *Stokoe s.n.* (SAM); hills from Graafwater to Clanwilliam, 1 000 ft., -/7/-, *Lamb 3579* (SAM); Grootkliphuis, 8 miles N. of Clanwilliam, in sandy restio veld, -/12/1940, *Leipoldt 3346* (BOL); Berg-valley/Zwartbaskraal, 3 km E. of main Road, 1 300 ft. (-BD), 11/7/1975, *Williams 2012* (NBG); Pikenierskloof, Clanwilliam Division (-DB), 2 000 ft., 29/6/1896, *Schlechter 7949* (BOL, G, GRA, P, PRE, S), 22/8/1966, *Pamphlett 108* (NBG); In convalle mont. Olifantsrivierbergen, 600 ft., 1/9/1894, *Schlechter 5116* (BOL, GRA); Sandstone slopes, Modderfontein, -/9/1930, *Gillett 3681* (BOL); N. end of Greys Pass near Citrusdal, 5/9/1964, *Esterhuysen 30740* (BOL); Greys Pass, 1 700 ft., 18/10/1958, *Acoks 19830* (PRE); Near Sewerfontein, 9 miles N. of Pikenierskloof Pass summit, 2 150 ft., 9/8/1977, *Williams 2321* (NBG).

—3219 (Wupperthal): Cedarberg, sandy flats between Heuning Vlei and Boontjieskloof, Clanwilliam Division (-AA), 31/12/1941, *Esterhuysen 7520* (BOL, PRE, SAM, NBG); N. Cedarbergen, sandy vlakte between Heuningvlei and Kompoort, 21/10/1945, *Esterhuysen 12120* (BOL, NBG, PRE), 19/10/1945, *Esterhuysen 12119* (BOL, SAM); Heuningvlei, -/1/1942, *Stokoe s.n.* (G, SAM); Ad montes prope Brakfontein, Clanwilliam Division (-AC), -/7/-, *Ecklon & Zeyher 848* (SAM, C, S); Waboomsrivier Mtns., N. of Brakfontein, 3 500 ft., 25/9/1936, *Compton 6517* (BOL, NBG); Cedarberg, Tafelberg shale band, 5 000 ft., 25/9/1942, *Esterhuysen 8094* (BOL); base of shale band, 29/12/1947, *Esterhuysen 14333* (BOL); shale band, base of Tafelberg, 5 000 ft., 24/6/1942, *Esterhuysen 7881* (BOL, NBG); Cedarberg, along the path to the Sneeuwberg hut, 4 000 ft., 23/3/1963, *Esterhuysen 30097* (BOL); Cedarberg, near Sneeuwberg hut, 4 250 ft., 1/12/1976, *Williams 2247* (NBG); Cedarberg, Wolfberg plateau, in sand in valley near Wolfberg Arch (-AD), 27/12/1962,



FIG. 5.  
Flower of *Diosma meyeriana* with scale in millimetres.

*Esterhuysen* 29988 (BOL); Near the waterfalls between Citrusdal and Elandskloof, Clanwilliam Division (-CA), -/8/1940, *Stokoe* 7675 (BOL, PRE, NBG); Duivelskloof, -/9/1950, *Stokoe* s.n. (SAM); S. Cedarbergen, shale band below Sneeuwberg, 5 000 ft., 11/12/1950, *Esterhuysen* 18019A (BOL); Elandskloof, 3/9/1938, *Hafström & Acocks* 788 (PRE), 27/8/1954, *Lewis* 4727 (SAM, STE), 20/8/1955, *Stokoe* s.n. (SAM), 4/8/1974, *Goldblatt* 2235 (MO, NBG); Middelberg Pass, Citrusdal area, 3 050 ft., 12/7/1975, *Williams* 2018 (NBG), 1/12/1976, *Williams* 2255 (NBG); lower slopes Olifants River Mtns. near Warmbaths, 23/9/1911, *Stephens & Glover*, *Percy Sladen Memorial Expedition* 7111 (BOL, GRA, NBG); The Baths, Modderfontein, 750 ft., 6/7/1935, *Compton* 5331 (BOL, NBG).

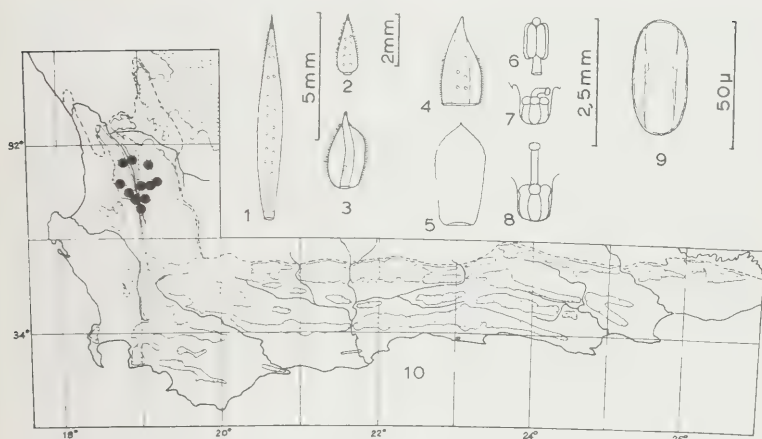


FIG. 6.

*Diosma meyeriana*: 1. leaf. 2. bract. 3. bracteole. 4. calyx lobe. 5. petal. 6. anther. 7. gynoecium at an early stage. 8. gynoecium at a later stage. 9. pollen. 10. distribution.

#### DISTRIBUTION AND VARIATION

*Diosma meyeriana* is confined to the Clanwilliam Division where it is found growing in sandy places in mountainous areas at altitudes of from 200 to 1 500 m (600 to 5 000 ft.). No significant variation has been observed. Plants are single-stemmed at base and do not coppice, but some from the outspan at the Middelberg Pass which were found to be many stemmed, may have been damaged by trampling.

*Diosma meyeriana* is recognised as a distinct species being a shrub arising from a single main stem, entirely glabrous; with leaves linear-lanceolate, sessile, alternate, adpressed erect with a small straight point; with flowers small, crowded, sub-sessile with petals glabrous, closing again after anthesis and persisting; with fruits not oily and with matt seeds. It looks very like *D. hirsuta* which however has leaves petiolate and *D. acmaeophylla* which has the petals pubescent.

**4. *Diosma aspalathoides*** Lam., Encycl. Meth. Bot. 2: 286 (1786). Type: *Diosma aspalathoides* Lam. Dict. (P-LA, holotype; C, P-J, isotypes).

*Diosma glabrata* G.F.W. Meyer ex Bartl. & Wendl. Diosm. in Bech. Bot. 1: 34 (1824). Type: Cap. b. Spei. Hesse s.n. (GOET, GOET-W, LD).

*Diosma depressa* Eckl. & Zeyh., Enum. Plant.: 108 (1835). Type: in arenosis planitie capensis prope "Rietvalley", altit. I (Cap). Nov. Dec., Ecklon and Zeyher 851 (C, SAM).



*Shrubs* 1–1,3 m tall with several stems arising from an underground stump of great age, not burnt off for many years. *Branches* erect, variously bent, stiff, wiry, soon leafless, glabrous; bark light brown becoming grey, the uppermost knotty with leaf scars. *Branchlets* numerous, short, erect, very slender, pale green sparsely and minutely puberulous, not hidden by the leaves. *Leaves* vary from 10 mm long, 1,3 mm broad on young shoots to 2,7 mm long, 1,2 mm broad on short flowering branchlets, linear-elliptic, acute or sub-obtuse, short-petiolate, glabrous, alternate, spreading-erect; apex recurved, in longer leaves with a sharp point, in shorter leaves rather blunt with the mucro deflected outwards; hyaline margins smooth or irregularly denticulo-serrulate; abaxially round keeled with a row of gland dots to either side. *Inflorescence* terminal; *flowers* pedicellate, up to three in a reduced raceme, 9–10 mm diam., green in the centre with white petals; buds large, globose, slightly acute at the apex. *Bract* 2,5–2,8 mm long, 1,1–1,3 mm broad, lanceolate-oblong, obtuse with a blunt callus, glabrous, spreading; hyaline margins somewhat irregularly serrulate, very sparsely ciliate at base; abaxial surface gland-dotted to either side of the prominent midrib. *Bracteoles* two, 1,7–2 mm long, 0,9 mm broad, lanceolate-oblong, obtuse with a small blunt callus, glabrous, spreading; hyaline margins rather narrow, irregularly serrulate; abaxial surface gland-dotted to either side of the midrib. *Calyx lobes* five, 2,2 mm long, 2 mm broad, deltoid, obtuse, glabrous; hyaline margins very sparsely and minutely ciliate below; abaxial surface with two rows of gland dots. *Petals* five, 3,5 mm long, 3 mm broad, orbicular, glabrous, white, spreading, sessile, connate with the lobe of the disc at the base. *Staminodes* none. *Filaments* five, becoming 2,7 mm long, acicular, spreading, glabrous. *Anthers* five, 1,3 mm long, 1,1 mm broad, yellow; apical gland semi-immersed, globose. *Pollen* 53  $\mu$  long, 28  $\mu$  broad, elliptic. *Disc* 4 mm diam., sinuate-crenulate, standing open, green, fleshy, exudes nectar. *Stigma* 0,3 mm diam., capitate, green, globose. *Ovary* 5-carpellate, 0,9 mm long, 1,2 mm diam., glabrous; apices obtuse. *Fruit* 5-carpellate, 14 mm long, 10 mm diam., glabrous, gland-dotted, short-pedicellate above the calyx; *horns* 1,5–4 mm long, spreading at 45°. *Seed* 5,8–6,3 mm long, 2,5 mm broad, black, shining; aril white.

It would appear that the type material for this species was collected by Sonnerat when he called at the Cape on his way to the East in 1773. The earliest collection may have been that of Auge which is to be found in the herbarium of the British Museum (Nat. Hist.). The above description prepared from fresh material amplifies those previously given.

#### SPECIMENS EXAMINED

CAPE—3318 (Cape Town): 3 miles E. of Langebaan (-AA), 10/10/1931, *Salter* 3912 (BOL); near Hopefield (-AB), *Bachmann* 297 (BOL); 13 miles S.E. by E. of

Hopefield, c. 100 ft., 13/10/1959, *Acocks* 20676 (BOL); Ysterfontein, Darling, near beach (-AC), 30/9/1926, *Grant* 2588 (BOL), -/7/1938, *Esterhuysen* 2774 (BOL), 1/8/1938, *Cohen s.n.* (NBG); 4 miles E. of Ysterfontein, 27/8/1936, *Salter* 6229 (BOL); Pampoenvlei, Darling (-AD), 11/9/1944, *Henrici* 3756 (BOL, NBG); Mamre/Ysterfontein, -/8/1931, *L. Bolus s.n.* (BOL 21298); Darling, -/9/1937, *Eames s.n.* (BOL), 11/9/1950, *Johns s.n.* (NBG); Slangkop near Darling, 28/9/1953, *Compton* 24379 (NBG); in dunis arenosis prope Groenkloof, Mamre (-CB), 300 ft., -/10/1878, *H. Bolus* 4260 (BOL); in sabulosis (altit I, II) prope Groenekloof, Sept/Oct, *Ecklon & Zeyher* 850 (W, SAM); Mamre, -/9/1939, *Walgate s.n.* (BOL); Mamre Road, 14/8/1946, *Leighton* 1825 (PRE); Mamre hills, Malmesbury Division, 24/9/1945, *Compton* 17441 (NBG); on road to Springfontein Strand near Mamre, Malmesbury Division, 600 ft., 11/8/1977, *Williams* 2322 (NBG); near Melkbosstrand, Cape Division, -/9/1940, *Esterhuysen* 4861 (BOL); near Bokbaai, 15/9/1940, *Esterhuysen* 3832 (BOL, PRE); Buffelsrivier, strandveld near Bokbaai, 100 ft., 18/10/1962, *Taylor* 4171 (PRE); Bokbaai, 21/2/1962, *Joubert* 543 (STE); in arenosis planitie capensis prope Rietvalley, altit. I (-CD), Nov/Dec, *Ecklon & Zeyher* 851 (C, SAM); Kaapse Vlakte bei Blaauwberg, 200 ft., (III, E, b), 25/7/1826, *Drège* 7130 (P, W); South base of Koeberg, Cape Division (-DA), -/9/1926, *Pillans s.n.* (BOL); On road to Atlantis near Mamre, Malmesbury Division, 450 ft., 8/9/1975, *Williams* 2064 (NBG), 9/12/1975, *Williams* 2160 (NBG); Melkbosch turning, Cape Division, 21/7/1946, *Compton* 18105 (NBG); Riverlands, Malmesbury Division, 2/11/1978, *Esterhuysen* 35080 (BOL); 24 miles along the road to Malmesbury after the turn off from the N9, 3/10/1969, *Esterhuysen s.n.* (BOL); Vissershok, Cape Town/Malmesbury road (-DC), 23/9/1932, *Salter* 2707 (BM, BOL); Milnerton, Cape Division, 19/9/1942, *Compton* 13729 (NBG).



FIG. 7.

Flower of *Diosma aspalathoides* showing petals 3 mm diam.

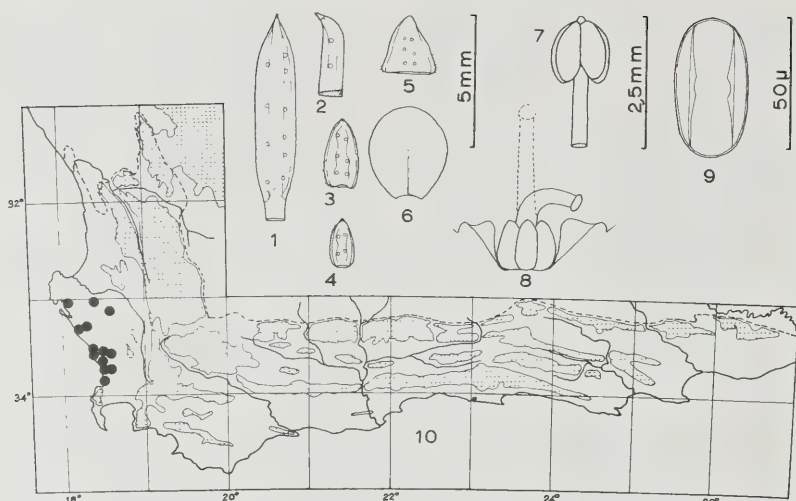


FIG. 8.

*Diosma aspalathoides*: 1, leaf. 2, leaf tip side view. 3, bract. 4, bracteole. 5, calyx lobe. 6, petal. 7, anther. 8, gynoecium with lobes of disc. 9, pollen. 10, distribution.

Without precise locality: *Auge* s.n. (BM), *Nelson* s.n. (BM), *Harvey* 241 (BM), *Roxburgh* s.n. (BM), *Hesse* s.n. (GOET, LD), *Sieber* 194 (K, P), *Sonnerat* s.n. (P-LA, P-J).

#### DISTRIBUTION AND VARIATION

*Diosma aspalathoides* is found only on the sandy coastal plain of the south western Cape, nearly always fairly close to the sea, from Milnerton in the south to Langebaan in the north. The plants grow in deep sand and possess a stout root which can withstand veld fires and the very disturbing activities of the mole rat.

The leaves on the same plant are variable. Those on vigorously growing shoots are the longest and possess a pungent mucro and those on the upper branchlets of mature plants are short and recurved with a blunt mucro.

*D. pedicellata*, a very similar species with a distribution extending inland as well as along the same coastal plain but distinguished by having smaller flowers and straight acute leaves, may well be found, when sufficient material becomes available, to grade into *D. aspalathoides*.

*Diosma aspalathoides* is considered to be a distinct species being a shrub with several stems arising from a stout persistent subterranean lignotuber, glabrous in most parts; having leaves short-pedicellate, round-backed or

two-ribbed when dry with two rows of gland dots, the upper leaves usually recurved at the apex with a blunt point; having flowers pedicellate, about 10 mm diam., with petals more than 2,5 mm diam. and the disc 4 mm diam. It differs from *D. pedicellata* which has leaves with a straight point and a narrow midrib when dry and flowers in slender reduced racemes, 7 mm diam. with petals less than 2,5 mm broad. It differs from *D. acmaeophylla* which has sessile leaves.

Common name "Haasboegoe".

**5. *Diosma pedicellata*** Williams in Jl S. Afr. Bot. **45**: 175 (1979). Type: CAPE—3218 (Clanwilliam): 6 km north of Papkuilsfontein, near Aurora, Piquetberg Division (-CB), 76 m (250 ft.) alt., 11/8/1977, Williams 2328 (NBG, holotype; K, MO, PRE, isotypes).

*Diosma pedicellata* is a distinct species and differs in being usually a tall stiff much branched shrub, many stemmed at base, having leaves petiolate with a narrow midrib when dry and the apex with a straight point; flowers 7 mm diam.; calyx glabrous; petals spreading, glabrous, narrowly sessile with margins irregular; fruit becoming pedicellate above the calyx; seed shining.

In *D. hirsuta* the petals persist for a long time at the base of the ripening fruit, a character often seen on herbarium material but in *D. pedicellata* the petals soon delapse and are never seen to be associated with the ripening fruit.

*D. aspalathoides* Lam, which occupies a rather similar habitat in deep sandy soils mostly in the vicinity of Mamre, can be distinguished by its larger

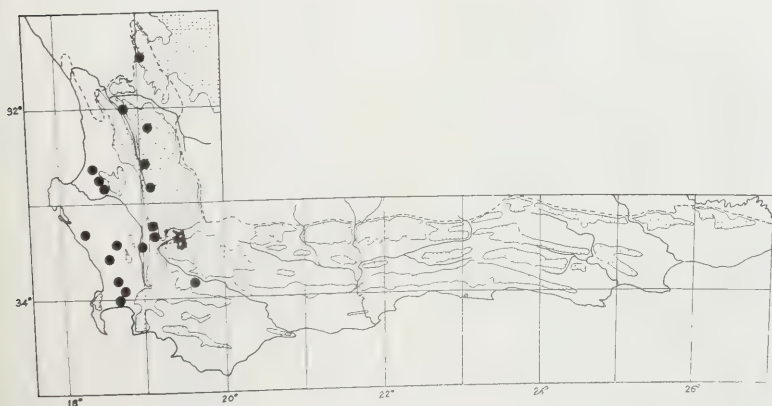


FIG. 9.  
*Diosma pedicellata*: distribution.

flowers 9–10 mm diam., with petals 3 mm broad and by its leaves which are often sharply recurved at the apex.

*D. acmaeophylla* Eckl. & Zeyh., which occupies a habitat somewhat further to the north, has similar large fruits with long horns that are also pedicellate above the calyx but can be distinguished by having leaves sessile not petiolate and by the minute pubescence on the petals and calyx.

#### ADDITIONAL SPECIMENS EXAMINED

CAPE—3219 (Wupperthal): Boontjieskloof N.E. of Pakhuis, Clanwilliam Division (-AA), 23/9/1969, *Esterhuysen 32208* (BOL).

—3319 (Worcester): South of Scherpenheuvel and the Breede River, Roodekleigat, Tafelkoppie, Worcester Division (-DC), 750 ft., 25/11/1980, *Williams 3101* (NBG).

**6. *Diosma hirsuta* L., Sp. pl. 1: 198 (1753);** Esterhuysen in Adams and Salter Flor. Cap. Pen.: 537 (1950). Type: in Herb. Hort. Cliff. (BM, holotype).

*Diosma rubra* L., Sp. pl. 1: 198 (1753). Iconolectotype: Pluk. almag. Bot. tab. 347, fig. "fol. 68. p 14".

*Diosma ericoides* L., Sp. pl. 1: 198 (1753). Inconolectotype: Pluk. Phyt. tab. 279, fig. 5.

*Diosma oppositifolia* L., Sp. pl. 1: 198 (1753) ex parte as to syn. Seb. Thes.

*Diosma pectinata* Thunb., Prod. Plant. Cap. 1: 84 (1794). Type: Herb. Thunb. 5701 (UPS).

*Diosma tenuifolia* Willd., Enum. Plant. Berol.: 258 (1809). Type: Hort. Bot. Berol. Willdenow 4793 (B).

*Diosma longifolia* Wendl., Coll. 1: 61. t. 19 (1806). Type: Hort. Herrenh. (GOET-WENDL).

*Diosma ericaefolia* Andr., Bot. Rep. t. 451 (1807).

*Diosma pinifolia* Fisch., Cat. Gorensk. 1: 94 (1808) nom. nud.

*Diosma ambigua* Bartl. & Wendl. Diosmae in Beitr. Bot. 1: 42 (1824). Type: *Otto s.n.* (GOET-WENDL).

*Diosma linifolia* Hort. ex Bartl. & Wendl. Diosmeae in Beitr. Bot. 1: 44 (1824) nom. nud.

*Diosma vulgaris* Schlechtendal in Linnaea 6: 200 (1831), nom. superf. Type: as for *D. hirsuta*, *D. rubra*, *D. oppositifolia*, *D. longifolia* and as for *D. ambigua* above.

*Diosma simsiana* Eckl. and Zeyh., Enum. Plant.: 108 (1835) excl. syn. *D. ericoides* Sims. Type: in latere montis Tafelberg septentrionem spectante altit II. Cap. Febr. Mart. Ecklon & Zeyher 847 (SAM).



*Diosma macrosticta* Presl., Bot. Bemerk.: 31 (1844), nom. superf. Type: *D. ambigua* Bartl. & Wendl.

*Diosma vulgaris* Schldl. var. *rubra* Sond. in Flor. Cap. 1: 374 (1860).

*Diosma vulgaris* Schldl. var. *longifolia* Sond. in Flor. Cap. 1: 375 (1860).

*Diosma vulgaris* Schldl. var. *hirsuta* Sond. in Flor. Cap. 1: 375 (1860).

#### PRE-LINNAEAN CITATIONS

*Hijpericum afr: frutesc: odorat, fl. albo* Cod. Witsen. (c. 1682–1687). Cat. Afr. Mus. 2: 61. C 362 (1967).

*Erica Aethiopica Rosmarini sylvestris folio, eleganter punctato; flore purpureo tetrapetalo.* Pluk. Almag. Bot. t. 347. fo. 68. pl. 4 (1696) excl. syn.

*Ericaeformis, Coridis folio, Aethiopica, Floribus pentapetalis in apicibus.* Pluk. Almag. Bot.: 136 (1696).

*Spirae africana lariceis foliis.* Raj. Suppl. Dendr.: 91 (1704).

*Spiraea afric: odorata foliis pilosis.* Comm. Hort. Med. Amst.: 3 (1706), Boerh. Ind. Alt. Plant. 2: 238 (1720), Mill. Dict. Ed. 2 (1733).

*Hypericum, Africanum, vulgare; seu Bocho Hottentotorum; flore albo; frutescens.* Seb. Thes. 2: 41. t. 15. No. 5 (1735).

*Diosma foliis linearibus hirsutis.* Linn. Hort. Cliff.: 71 (1737), Roy. Lugd. Bat.: 435 (1740), Wach. Ultr. Ind.: 47 (1747), Fabr. Helmst.: 145 (1759).

#### ICONES

*Hijpericum* . . . Cod. Witsen. (1682–1687).

*Erica aethiopica* . . . Pluk. Almag. Bot. t. 347 fig. fol. 68. pl. 4 (1696).

*Ericaeformis* . . . Pluk. Phyt. tab. 279, fig. 5 (1691).

*Spiraea africana* . . . Comm. Hort. Med. Amst. t. 3 (1706).

*Hypericum* . . . Seb. Thes. t. 15, No. 5 (1735).

*Diosma hirsuta* L. Gaertn. Fruct. 2. t. 94 (1791), Wendl. Collect. t. 27 (1806), Lam. Rec. Plant. t. 127, *Diosma* 4 (1823), Bartl. & Wendl. *Diosm.* 1. t. A, fig. 2 (1824), Levyns, Guide Flor. Cap. Pen.: 179, Fig. 90 (1966), Mason, West. Cap. Sandv. Flow. t. 60, fig. 2 (1972).

*Diosma longifolia* Wendl. Collect. t. 19 (1806).

*Diosma ericaefolia* Andr. Bot. rep. t. 451 (1807).

*Diosma rubra* L. Edw. Bot. Reg. 7. t. 563 (1821), Lodd. Bot. Cab. t. 1298 (1828).

*Coleonema album* Bartl. & Wendl. ex errore in Chun Deutsch. Tiefs.-Exped.: 143 (1908).

*Diosma vulgaris* Schldl. Kidd, Wild Flow. Cap. Pen. t. 23, fig. 7 (1950).

*Shrubs* up to 0.5 m tall with many stems arising from a stout rootstock, last burnt about 4 years ago. *Branches* long, slender, erect, becoming glaucous when the epidermis splits off; leaf scars projecting as distinct lumps.

*Branchlets* fairly short, erect, scattered, densely crisped pubescent, yellow at first becoming reddish-brown, leafy, very short at the inflorescence. *Leaves* on vigorous young stems up to 22 mm long, more normally about 12 mm long, 0.9 mm broad, linear-lanceolate, alternate, erect; apex acute with a sharp erect mucro; margins narrowly cartilaginous, villous-ciliate at first; ad-axial surface glabrous, more or less flat when fresh; abaxial surface convex showing a double midrib when dry, crisped pubescent at first, one row of gland dots to either side of the midrib; narrowing slightly at the base to a petiole about 1 mm long. *Inflorescence* terminal in very much reduced compound racemes; *flowers* 5 mm diam., pedicellate. *Bract* 1.2 mm long, 0.5 mm broad, lanceolate, glabrous, without gland dots; apex sub-obtuse, somewhat thickened; margins ciliate, translucent below. *Bracteoles* two, 1 mm long, 0.5 mm broad, lanceolate, glabrous without gland dots, ciliate; apex acute with a small translucent point. *Calyx lobes* five, 1.5 mm long, 1 mm broad, lanceolate, glabrous, gland-dotted; apex sub-acute, thickened, margins ciliate, translucent. *Petals* five, 2.5 mm long, 1.7 mm broad, ovate, glabrous, white, without gland dots, spreading, connate at the base with the lobes of the disc; margins irregular with about 3 incipient cilia to either side below. *Staminodes* none. *Filaments* five, becoming 1.2 mm long, acicular, glabrous, spreading after anthesis. *Anthers* five, 0.8 mm long, 0.7 mm broad, yellowish; apical gland globose, semi-immersed. *Pollen* 45  $\mu$  long, 25  $\mu$  broad, oblong. *Disc* 5-sinuate-crenulate, green or reddened, stands well open, exceeds the ovary by a long way, exudes nectar. *Stigma* 0.35 mm diam., capitellate, pale green. *Style* becoming 1.2 mm long, normally fairly erect, glabrous. *Ovary* 5-carpellate, 7.5–12.5 mm long including the horn 1.5–3 mm long (observed from 17 localities), carpels glabrous, gland-dotted, oily and strong smelling when fresh if crushed. It appears that one, two or more of the carpels fail to be fertile. *Seed* 5.5–7 mm long, 2.4–3 mm broad (observed from 10 localities), black, shining; aril streaked with black.

*Diosma hirsuta* was amongst the earliest of Cape plants to receive recognition in Europe. Claudius' drawing, or what may be a copy of the original, done at the Cape sometime between 1682 and 1687 is to be found in what is believed to be the "Codex Witsenius" now preserved in the Africana Museum at Johannesburg. A note, written on the drawing translated reads: "African Hypericum, a scented shrub with white flowers, called Buchu by the Hottentots. Those that have been collected are dried and made into a nice smelling powder which is used to sprinkle on the head and clothes. It grows plentifully on the slopes of the mountain, is two feet high and flowers in September". The drawing depicts a typical plant of *D. hirsuta* as it occurs in its natural state, even going so far as to clearly show the persistent root-stock from which the plant may regenerate after fires.

Probably the first published illustration of *D. hirsuta* appeared in

Plukenet's *Almagestum Botanicum* t. 347, fig. 7 (1696). The original specimen from which the drawing was made is preserved in the Sloane Herbarium Vol. 102, fol. 179 at the British Museum (Nat. Hist.). It is a small flowering twig 110 mm long.

The original water colour drawing, from which the engraving of the plate *Spiraea Africana odorata foliis pilosis* Fig. 3 in Commelin's *Hort. Med. Amst.* (1706) was made, is preserved in the library of the Hortus Botanicus at Amsterdam. Although Linnaeus cites this illustration with his original description of *D. hirsuta* in the *Hortus Cliffortianus* (1737) this cannot be regarded as the type because he was already in possession of living material growing in the gardens of George Clifford at Hartecamp in Holland. The holotype is therefore the specimen beautifully mounted as though growing in an urn and preserved in the Clifford Herbarium at the British Museum (Nat. Hist.) with an isotype at the Linnaean Herbarium in London. These somewhat etiolated specimens have the appearance of plants grown under unnatural conditions and it is also quite possible that the pubescence noticed by Linnaeus was due to the same cause, it being very unusual to find such hirsute specimens in the wild.

The fact that *D. hirsuta* had been in cultivation in many gardens in Europe, that it is a somewhat variable species and that cultivated plants differ somewhat in appearance from those grown in the wild, led to a proliferation in the nomenclature with the result that no less than fourteen different specific names had been proposed by the year 1884. The above description, prepared from fresh material collected from the north slopes of the Sentinel at Hout Bay (*Williams 1856*), might be considered as typical. Such variation as has been noticed is subsequently mentioned.

#### SPECIMENS EXAMINED

*Note:* Specimens in the following herbaria have been examined and identified: B, BM, BOL, C, G, GRA, GOET, K, LD, LINN, NBG, P, PRE, S, SAM, UPS, W. They are far too numerous to be listed and so there follows a selection of collections in order to provide a record of the distribution of the species. Only one specimen is cited from each quarter degree square in which the species has so far been located and only the specimens here listed have been shown on the distribution map.

CAPE—3218 (Clanwilliam): hills N.W. of Moutonsvlei. Piquetberg Division (-DC), 6/11/1934, *Pillans 7327* (BOL).

—3219 (Wupperthal): Cedarbergen. Pakhuis/Heuningvlei. Clanwilliam Division (-AA), 3 000 ft., 19/10/1953. *Esterhuysen 12957* (BOL); valley between Sunberg and Vensterberg near Algeria. Clanwilliam Division (-AC), —/12/1939. *Esterhuysen 2502* (BOL, PRE); Dasklip Pass. Cardouw Mtns. Piquetberg Division (-CC), 2 400–2 600 ft., 6/10/1971, *Williams 1550* (NBG, STE).

—3318 (Cape Town): near Yzerfontein, Malmesbury Division (-AD), -/7/1938, *Esterhuysen 2775* (BOL); in clivis montis Tabularis supra Orange Kloof, Cape Division (-CD), c. 2 000 ft., 21/2/1892, *Schlechter 363* (BM, GRA); Pella near Mamre, Malmesbury Division (-DA), 9/6/1969, *Axelson 23* (NBG); Achter Paarl, Paarl Division (-DB), 21/8/1938, *Barker 356* (NBG); Hazendal, Kuils River, Cape Division (-DC), 14/8/1961, *Rycroft 2299* (NBG); Bottellary Road, Stellenbosch Division (-DD), 350 ft., 9/12/1975, *Williams 2195* (NBG).

—3319 (Worcester): Boboskloof, Ceres Division (-AA), 1 020 m, 22/11/1975, *Williams 2150* (NBG); Schurfdeberg Pass, Ceres Division (-AB), 30/10/1950, *Compton 22273* (NBG); Mtns. above Tulbagh Waterfall, Tulbagh Division (-AC), 16/9/1928, *Hutchinson 408* (BOL, K, PRE); N. of Prince Alfreds Hamlet, Ceres Division (-AD), 1 750 ft., 23/10/1974, *Williams 2117* (NBG); in convalle Hex River prope De Doorns, Worcester Division (-BC), 1 700 ft., -/4/1907, *H. Bolus s.n.* (PRE); Bainskloof Mts. near Sebastiaanskloof, Paarl Division (-CA), 25/5/1940, *Esterhuysen 1976* (BOL); Brandvalleiberg, Worcester Division (-CB), -/6/1940, *Esterhuysen 1984* (BOL); Klein Drakenstein Mtns. upper Kasteelskloof, Paarl Division (-CC), 2 200 ft., 12/11/1970, *Haynes 449* (PRE, STE); Silverstream, Donkerhoek Mtns., Caledon Division (-CD), 3 000 ft., 23/11/1974, *Williams 1936* (NBG); in clivis montis Hex River Valley, Worcester Division (-DA), 1 700 ft., -/10/1881, *Tyson 674* (PRE); Dassieshoek, Langebergen, Robertson Division (-DB), 3/9/1961, *Esterhuysen 29118* (NBG); McGregor, Robertson Division (-DD), 24/9/1941, *Walgate 352* (NBG).

—3418 (Simonstown): Hout Bay, N. slopes of the Sentinel, Cape Division (-AB), 500 ft., 28/8/1973, *Williams 1856* (NBG, PRE, STE); Cape Point area, Cape Division (-AD), 29/11/1939, *Walgate s.n.* (NBG); Cape Flats, 2 miles W. of Faure, Stellenbosch Division (-BA), 19/1/1934, *Salter 4248* (BM, BOL); Somers West, Stellenbosch Division (-BB), 22/8/1942, *Parker 3711* (NBG, PRE); Rooi Els on sandy banks, Caledon Division (-BD), 15/5/1947, *Parker 4187* (NBG).

—3419 (Caledon): Viljoens Pass, Caledon Division (-AA), 2 000 ft., 26/8/1940, *Compton 9208* (NBG); Zwartberg, Caledon Division (-AB), 2 000 ft., 16/10/1894, *Schlechter 5538* (PRE); Honigklip, Bot River/Kleinmond, Caledon Division (-AC), 19/11/1955, *Taylor 4850* (NBG, STE); Vogelgat Nature Reserve, near Hermanus, Caledon Division (-AD), 200 ft., 3/9/1976, *Williams 2198* (NBG); Snyerskraal, hills S. of Genadendal, Caledon Division (-BA), 900 ft., 6/10/1977, *Williams 2364* (NBG); Riviersonderend Mtns. foothills near Bokrivier farm, Caledon Division (-BB), 800 ft., 13/4/1974, *Williams 1895* (NBG); Sondagskloof Pass summit, Bredasdorp/Caledon Divisions (-BC), 900 ft., 26/7/1962, *Taylor 3617* (PRE, STE); Napier, on farm Eenheid, Bredasdorp Division (-BD), *Jordaan 64* (STE); Strandskloof, Bredasdorp Division (-CB), 100 ft., 9/9/1976, *Williams 2200* (NBG); Groenkloof on Rd. to Pearly Beach, Bredasdorp Division (-DA), 250 ft., 17/10/1976, *Williams 2115* (NBG); Boskloof, S. side of Bredasdorp Mtns., Bredasdorp Division (-DB), 750 ft., 24/2/1977, *Williams 2278* (NBG).

—3320 (Montagu): Cogmanskloof, Langebergen, Montagu Division (-CC), 8/10/1922, *Tredgold 430* (PRE); Strawberry Hill, Langeberg, Heidelberg Division (-DD), -/12/1954, *Stokoe s.n.* (SAM 68917).

—3420 (Bredasdorp): Marloth Reserve, Swellendam Division (-AB), 900 ft., 28/10/1971, *Williams 1565* (NBG); Elandspad Farm, S. Potteberg, Swellendam Division (-BC), 900 ft., 12/4/1972, *Williams 1643* (NBG); Potteberg Estates near Cape Infanta, Swellendam Division (-BD), 500 ft., 16/6/1974, *Bayliss 6584* (NBG); Bredasdorp Poort, S. side, Bredasdorp Division (-CA), 150 ft., 11/1/1972, *Williams 1619* (NBG); near Struisbaai, Bredasdorp Division (-CC), 26/10/1940, *Esterhuysen 4859* (BOL).

—3321 (Ladismith): Garcias Pass, N. side, Riversdale Division (-CC), 1 900 ft., 23/12/1971, *Williams 1612* (NBG, PRE, STE).



- 3421 (Riversdale): Verkykerskop, Corrente River Road, Riversdale Division (-AA), 1 050 ft., 27/12/1977, *Williams* 2424 (NBG).
- 3323 (Willowmore): Formosa Peak, Uniondale Division (-DC), 30/1/1941, *Esterhuysen* 4652 (BOL); Joubertina, Uniondale Division (-DD), 24/1/1941, *Esterhuysen* 6893 (BOL).
- 3324 (Steytlerville): Assegaaibos, foot of road to Zuuranys, Humansdorp Division (-CD), 700 ft., ~/11/1941, *Fourcade* 5474 (NBG).
- 3424 (Humansdorp): Hofmansbosch, Humansdorp Division (-AB), 5/1/1919, *Britten* 1124 (PRE, GRA); Kruisfontein, Humansdorp Division (-BA), 11/9/1897, *Galpin* 3853 (PRE, GRA).

#### DISTRIBUTION

*Diosma hirsuta* does not form dense stands, the plants being usually found to be somewhat dispersed in the fynbos. They occur mostly in the south western Cape extending as far north as the Pakhuis Pass near Clanwilliam and eastwards to Garcias Pass near Riversdale with outliers a further 240 km to the east from the vicinity of Joubertina to near Humansdorp. They grow at altitudes of from 90 to 900 metres above sea level in quartzitic soil derived from the Table Mountain geological series in stony gravelly ground but seldom in deep sandy soil.

#### VARIATION AND HYBRIDISATION

From the mass of material filed in the past under *Diosma vulgaris* in numerous herbaria it has been found possible to extract specimens representing as distinct species *Diosma acmaeophylla* Eckl. & Zeyh., *Diosma aspalathoides* Lam., *Diosma parvula* Williams, *Diosma pedicellata* Williams and *Diosma subulata* Wendland.

However, material that remains represents a decidedly variable species. Esterhuysen (1950), with reference to the populations of *Diosma hirsuta* L. found on the Cape Peninsula, remarked upon the degree of variation and noted the fact that the forms merge into one another and that no varieties could be upheld. Although all plants have a persistent root that may withstand occasional fires they vary in other respects as follows.

They may have few stems (1) or very many stems (2). Branchlets may be in varying degree crisped pubescent (3), puberulous (4) or glabrous (5). Leaves may vary in length from about 9.5 mm (6) to 41 mm (7), from being villous ciliate (8) to eciliate (9), from straight (10) to recurved (11) and from being fairly sparse (12) to closely packed (13). Shrubs may vary from bearing fairly few flowers (14) to being densely floriferous (15) and the flowers may have the calyx reddened (16) or green (17).

The following voucher specimens relating to the foregoing numbered variations are preserved at the Compton Herbarium (NBG): (1) Zeekoegat, Heidelberg Division, *Williams* 2619. (2) Zeekoegat, Heidelberg Division,





FIG. 10.

Flower of *Diosma hirsuta* with style deflexed.

*Williams* 2618. (3) Blue Downs near Blackheath, *Williams* 2158. (4) Vogelgat near Hermanus, *Williams* 2198. (5) Olifantskloof near Riviersonderend, *Williams* 2500. (6) Fernkloof, Hermanus, *Williams* 1534. (7) Bokrivier, Riviersonderend, *Williams* 1895. (8) The Sentinel, Hout Bay, *Williams* 2242. (9) Olifantskloof near Riviersonderend, *Williams* 2500. (10) Prince Alfreds Hamlet, Ceres Division, *Williams* 2117. (11) Toekoms, south side Bredasdorp Mountains, *Williams* 2277. (12) Modderasrivier, west of Genadendal, *Williams* 2231. (13) Gansbaai/Strandskloof, Caledon Division, *Williams* 2205. (14) Diepgat/Ertjiesvlei, Caledon Division, *Williams* 2347; (15) Diepgat, Caledon Division, *Williams* 2213. (16) Fernkloof, Hermanus, *Williams* 1534. (17) Fernkloof, Hermanus, *Williams* 1535.

These variations cannot be correlated with any environmental factor. Differing forms have been quite frequently found growing in localities quite close to one another. It may be significant that plants with somewhat recurved leaves have been found growing on soils with a gravelly subsoil.

Hybrids are extremely rare but one putative hybrid with *Diosma oppositifolia* L. has been collected by Esterhuysen near Steenbras Siding together with the putative parents.

CAPE—3418 (Simonstown): Steenbras Siding, Caledon Division (-BB), -7/1940, *Esterhuysen* 2685 (BOL) = *D. hirsuta* X *D. oppositifolia*, *Esterhuysen* 2690 (BOL) = *D. hirsuta*, *Esterhuysen* 2686 (BOL) = *D. oppositifolia*.

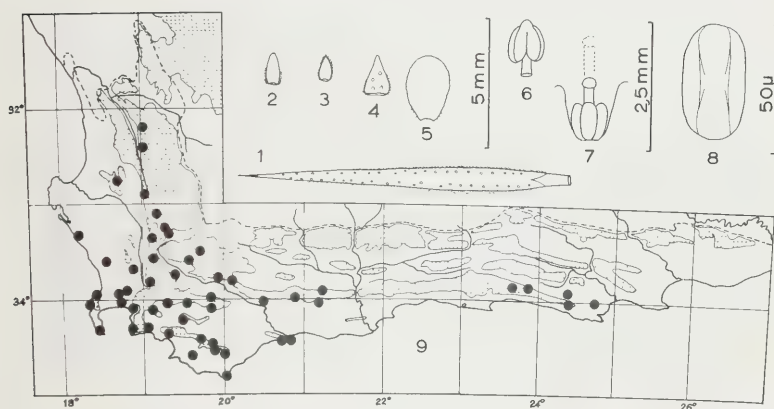


FIG. 11.

*Diosma hirsuta* from The Sentinel, Hout Bay (Williams 1856): 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, anther. 7, gynoecium. 8, pollen. 9, distribution showing only one locality where collected in each quarter degree square.

*Diosma hirsuta* is recognised as a distinct species being a fairly low shrub with several stems arising from a persistent underground rootstock; with leaves alternate, petiolate, linear-lanceolate, acute with a sharp straight point, having the midrib often flattened when dry; with flowers fairly numerous in very much reduced racemes, the petals ovate, glabrous, spreading, persisting for a long time, the disc standing open sinuate-crenulate without staminodes. It differs from *D. acmaephylla* Eckl. & Zeyh. and *D. fallax* Williams which have leaves sessile; from *D. aspalathoides* Lam. which has petals much larger and the apex of the leaf abruptly recurved; from *D. parvula* Williams which is much smaller in all floral parts with the petals retuse and from *D. pedicellata* Williams with fruits pedicellate above the calyx, petals soon delapsing and with the leaf with a rounded or narrow midrib when dry.

**7. *Diosma parvula* Williams, sp. nov.** propria propter fruticem glabrum ad basim monocaulem ramulis filiformibus, foliis eciliatis, floribus pedicellatis 2,5 mm diam. petalis retusis, fructis parvulis.

*Frutex* c. 0,4 m, laxiusculus, ad basim monocaulis. *Rami* graciles, erectiusculi, pauci, glabri sparsim glanduloso-punctati. *Ramuli* filiformi erecti, pauci. *Folia* 9, 5-13 mm longa, 0,8-0,9 mm lata, linear-lanceolata, acuta, pungento-mucronata, breve petiolata, glanduloso-punctata, glabra, nervis alternis; marginibus anguste hyalini. *Inflorescentia* terminalia, reducto racemosa, c. 12-florifera: *flos* c. 2,5 mm diam., cyanthiformis, pedicellatus.

*Bractea* 0,5-1,5 mm longa, 0,3 mm lata, ovato-lanceolata, sparsim ciliolata. *Bracteolae* duae, ad basim pedicelli, 0,25-0,5 mm longae, 0,2 mm latae, ovato-lanceolatae, ciliolatae, pallidae, sparsim pubescentes. *Sepala* quinque, 0,5 mm longa, 0,6 mm lata, semi-elliptica, obtusa, glabra, sparsim ciliolata, in medio incrassata. *Petala* quinque, 1,3 mm longa, 1,3 mm lata, obovata, obtuso-retusa, glabra, alba, sessilia, persistentia. *Staminodia* 0. *Filia* quinque, 1 mm longa, glabra. *Antherae* quinque, ante anthesin 0,5 mm longae, 0,5 mm latae, vinosae, glabrae, glandula semi-immersa coronata. *Pollen* 41  $\mu$  longum, 21  $\mu$  latum, oblongum. *Discus* sinuato-crenulatus, patens, multipunctatus, nectarifer. *Stigma* 0,2 mm diam., capitellatum, globosum. *Stylus* 0,5 mm longus, glaber, erectus, deum cadens. *Ovarium* 5-carpellatum, 0,5 mm diam., glabrum, apicibus globosis. *Fructus* 5-carpellatus, 5,8 mm longus in toto, 5 mm diam., glaber, nitens, viridus, glanduloso-punctatus; cornua c. 1 mm longa, apicibus atroviridis, patentibus. *Semen* 3,8 mm longum, 2 mm latum, piceum, nitens; arillus nigrifasciatus.

*Type*: CAPE—3420 (Bredasdorp): south side of Potberg, 1,5 km W.N.W. of Bufeisfontein, Bredasdorp Division (-BC), 135 m alt., 8/4/1981, *Williams* 3126 (NBG, holotype; BOL, K, MO, PRE, S, STE, isotypes).

*Shrubs* about 0,4 m tall, rather lax, single-stemmed at base. *Branches* fairly erect, not numerous, slender, glabrous, smooth, sparsely gland-dotted, somewhat reddened. *Branchlets* erect, not numerous, filiform, straight, pale green at first, not hidden by the leaves. *Leaves* 9,5–13 mm long including the petiole about 1 mm long, up to 21,5 mm long in young plants, 0,8–0,9 mm broad, up to 1,2 mm broad in the largest leaves, acute with a straight sharp mucro, glabrous, alternate, spreading-erect; margins eciliate very narrowly translucent; adaxial surface flat; abaxial surface rounded, gland-dotted. *Inflorescence* terminal in much reduced racemes with about a dozen flowers opening from the apex downwards; *flowers* about 2,5 mm diam., white, cup-shaped, pedicellate. *Bract* at the base of the pedicel, 0,5–1,5 mm long, 0,3 mm broad, ovate-lanceolate, sparsely ciliate. *Bracteoles* two, at the base of the pedicel, 0,25–0,5 mm long, 0,2 mm broad, ovate-lanceolate, ciliate, sparsely pubescent on both sides, pallid. *Calyx lobes* five, 0,5 mm long, 0,6 mm broad, semi-elliptic, obtuse, glabrous, sparsely and minutely ciliate, thickened in the middle above. *Petals* five, 1,3 mm long, 1,3 mm broad, obovate, retuse, glabrous, white, sessile, thinner at the margins, fairly erect, arising below the margin of the disc, persisting for a long time. *Staminodes* absent. *Filaments* five, becoming 1 mm long, acicular, glabrous, erect in line with the petals. *Anthers* five, before anthesis 0,5 mm long, 0,5 mm broad, glabrous, wine-coloured; apical gland paler, semi-immersed. *Pollen* 41  $\mu$  long, 21  $\mu$  broad, oblong. *Disc* sinuate-crenulate, stands open,

more or less equals the ovary, may become bright red, exudes nectar from numerous pits on its surface. *Stigma* 0,2 mm diam., globose, capitate. *Style* becoming 0,5 mm long, glabrous, erect, eventually delapsing. *Ovary* 5-carpellate, 0,5 mm diam., glabrous, apices globose. *Fruit* 5-carpellate, all five seldom if ever developing a seed, 5,8 mm long overall, 5 mm diam., glabrous, shining, green, gland-pitted; *horns* about 1 mm long, dark green tipped, set at 45°. *Seed* 3,8 mm long, 2 mm broad, black, shining; aril streaked with black.

This rare species appears to have been first collected by C. A. Smith in 1927 near Bredasdorp, a town with which, being an Albertyn, he was closely associated. It was the discovery of a small population near the Potberg in 1980 by C. J. Burgers that enabled the author to obtain the fresh material used in the preparation of this description.

#### SPECIMENS EXAMINED

CAPE—3419 (Caledon): Grashoek, Bredasdorp Mountain (-DB), 6/12/1938, *Eric Wall s.n.* (S); flats between Bredasdorp and Elim, 5/8/1940, *Compton 9087* (NBG), *Esterhuysen 3099* (BOL, NBG).



FIG. 12.

*Diosma parvula*: flowers and fruit (photograph by C. Burgers).

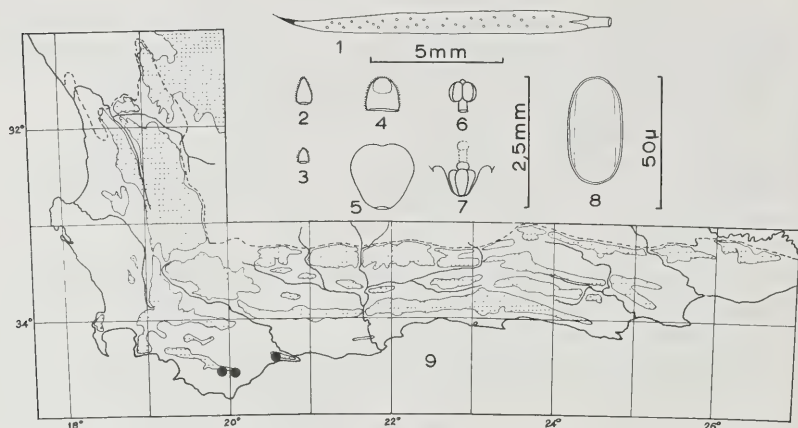


FIG. 13.

*Diosma parvula*: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, anther. 7, gynoecium. 8, pollen. 9, distribution.

—3420 (Bredasdorp): south side of Potberg, 1,5 km W.N.W. of Buffelsfontein, Bredasdorp Division (-BC), 135 m alt., 20/8/1980, *Burgers 2478* (CPA Nat. Cons. Herb.), 8/4/1981, *Williams 3126* (NBG, BOL, K, MO, PRE, S, STE); Driefontein, Bredasdorp (-CA), 200 ft. -/6/1927, *Smith 4301* (K, PRE); hills with an easterly aspect near Bredasdorp, -/4/1933, *L. Bolus s.n.* (BOL 20530, K).

#### DISTRIBUTION

*Diosma parvula* is apparently only found on the flats between Elim and Bredasdorp and again on the plain south of Potberg. The locality "Driefontein" given by Smith, close to Bredasdorp, is now overrun with wattles and so degraded that the species is unlikely to be still surviving in that area. It is very vulnerable to alien encroachment, occurring as it does in dark sandy soil near seepage areas associated with *Berzelia lanuginosa*. It has now been collected on the Elim flats near Jacobsdam, 20/10/1981, *Bean 737* (BOL) where the plants were found to be 1,5 m tall.

#### DISCUSSION

*Diosma parvula* is recognised as distinct being a glabrous shrub, regenerating only from seed after fires; with very slender branchlets, eciliate leaves; flowers 2,5 mm in diam., pedicellate with petals retuse and having a very small fruit. It is most like *Diosma hirsuta* which however coppices after fires, has flowers 4–5 mm in diameter and much larger fruits.



**8. *Diosma fallax*** Williams, nom. nov., vice *Diosma eckloniana* Sond. in Flor. Cap. 1: 375 (1860). Type: 89.9, Ecklon No. 455 (S, holotype).

Name invalidated by *Diosma eckloniana* (Schldl.) D.Dietr., Synops. Plant. 1: 826 (1839) which is a species of *Agathosma*.

A shrub more than 300 mm tall, apparently quite dense, prickly and twiggy rather than lax, habit unusual in that the leafy branchlets are scattered about and not concentrated towards the top of the shrub. Branches numerous, short, not straight, glabrous with a smooth brown bark. Branchlets very numerous, short, slender, alternate, spreading, with a shining smooth bark, not hidden by the leaves. Leaves to 14 mm long, 1 mm broad, linear, acute, with a long sharp needle-like point, glabrous, sessile, alternate, more or less spreading; margins very entire, narrowly translucent; abaxial surface convex without any keel with gland dots more or less in two rows; adaxial surface concave. Inflorescence terminal with flowers few, crowded together in very much reduced racemes on glabrous pedicels. Bract glabrous, a very much reduced leaf with a sharp point. Bracteoles two, lanceolate, acute, glabrous, eciliate, all 3 at the base of the pedicel. Calyx lobes five, 1 mm long, ovate-lanceolate, apiculate, glabrous, eciliate, gland-dotted; margins broad, translucent. Petals five, ovate, glabrous, 1–2 gland-dotted, spreading, persisting. Staminodes absent. Filaments five, 1.5 mm long, glabrous. Anthers five, with a globose apical gland. Disc 5-lobed, sinuate, stands open around the ovary. Stigma capitellate. Style glabrous. Unripe fruit 6 mm long, glabrous; horn 3 mm long with an immersed apical gland.

The type material now housed in the herbarium of the Natural History Museum at Stockholm consists of two twigs mounted on a single sheet. There are flowers and one immature fruit. The left hand specimen is 320 mm long with two labels "No. 455. 89.9" and "No. 455. *Diosma eckloniana* Sr. *Diosma* probabiliter species nova.". The inscription *Diosma Eckloniana* Sr. is almost certainly in Sonder's handwriting. The right hand specimen is 220 mm long and is labelled "*D. eckloniana*" in Sonder's hand. There is a capsule but no notes by Sonder. As this is the only specimen of this species that I have seen in any herbarium so far examined and as I consider it to have been seen by Sonder in the preparation of his description of his *Diosma eckloniana*, I have labelled it as the holotype.

According to Drège in *Linnaea* 19: 589 (1847) the locality indicated by 89.9 is "Swellendam, dry mountain ridge near the Riviersonderend, at Stormsvlei, Hassaquaskloof etc. as far as the Breederivier, 500–2 000 ft., September". Repeated searching of these mountains has as yet failed to produce this species.

A detailed examination of this type material has assisted in the preparation of the above amplified description of this species.

*Diosma fallax* is recognised as distinct being a shrub with a ragged habit,

entirely glabrous and eciliate; with leaves round backed linear, sessile, alternate, with a long sharp needle-like point; and with petals glabrous, 1-2 gland-dotted.

**9. *Diosma subulata* Wendl.**, Coll. Plant. **1.** t. 8 (1805). Iconotype: *Diosma subulata* Wendl. loc. cit. (BM, C, isotypes).

*Diosma vulgaris* Schldl. var.  $\alpha$  Sond. in Flor. Cap. **1:** 374 (1860)) ex parte. as to syn. *D. subulata* Wendl.

*Diosma vulgaris* Schldl. var.  $\beta$  Sond. loc. cit. Type: *D. oppositifolia* E. & Z. 837 ex parte.

*Diosma oppositifolia* Bartl. & Wendl. Diosm. in Beitr. Bot. **1:** 31 (1824) ex parte.

*Diosma pectinatum* Wendl. Enum. Plant.: 258 (1809) ex parte as to *D. pectinata* 4. (B-W 4790).

Icones: *Diosma foliis linearibus glabris acutis*. Mill. Fig. Plant. Pl. 124, fig. 1 (1760). *Diosma subulata*. Wendl. Coll. Plant. **1.** t. 8 (1805).

*Shrubs* up to 1,8 m tall, erect, single-stemmed at base with a dense crown of flowering heads. *Branches* erect, sometimes dichotomous, variously angled, glabrescent; bark smooth when green with horizontal leaf scars. *Branchlets* erect, short, crisped-puberulous, pinkish in colour, well clothed with leaves. *Leaves* vary in size being largest on young vigorous shoots and smallest towards the tips of the branchlets of the older shrubs, up to 17 mm long, 2,9 mm broad, average 11 mm long, 2 mm broad, linear-lanceolate (almost awl-shaped), acute with a straight sharp point, somewhat complicate when dry, glabrous, scabrous, erect, straight or sub-falcate, mostly opposite except in vigorous young shoots, the largest leaves may have a few hairs in the hollow towards the base; midrib prominent with about two rows of gland dots to either side; hyaline margins narrow, serrulate and ciliate becoming eciliate; petiole 1 mm long. *Inflorescence* terminal, solitary in very much reduced racemes; *flowers* c. 6 mm diam., petals white. *Bract* one, 4 mm long, 1,2 mm broad, leaf-like, lanceolate, mucronate, glabrous, ciliolate below, sessile, inflexed. *Bracteoles* two at the base of the pedicel, 1,8 mm long, 0,6 mm broad, lanceolate, glabrous, ciliolate, pallid, asymmetrical. *Calyx lobes* five, 2,3 mm long, 1,8 mm broad, deltoid, acute, mucronulate, glabrous, ciliolate, pinkish. *Petals* five, 2,5 mm long, 1,6 mm broad, ovate, glabrous, sparsely ciliolate below, sessile. *Staminodes* none. *Filaments* five, becoming reflexed and 2 mm long, acicular, glabrous. *Anthers* five, before anthesis 0,7 mm long, 0,7 mm broad, reddish-orange; apical gland minute. *Pollen* 60  $\mu$  long, 27  $\mu$  broad, obloid, very slightly narrowed in the middle. *Disc* 5-sinuate-crenulate, fleshy, exceeds the ovary by a long way, exudes nectar. *Stigma* 0,2 mm diam., capitellate, green. *Style* seldom deflexed at first, becoming 1,3 mm long, glabrous. *Ovary* 5-carpellate, 0,7 mm diam.,

glabrous. *Fruit* 5-carpellate, 10 mm long overall, glabrous, multi-gland-dotted; *horns* 2 mm long, apex somewhat bifid. *Seed* 5,5 mm long, 5,7 including the aril, 2,6 mm broad, black, shining; aril black and white.

*Diosma subulata* was apparently raised from seed in the Physic Garden at Chelsea some years before 1760 when it was figured by Miller in his *Gardeners Dictionary*. Later on it was in cultivation in the Royal Gardens at Hanover and figured by Wendland in his "Collection of Plants". It is most extraordinary that no herbarium specimen collected at the Cape in those early days has been found and one has no idea where the plants occurred from which the seeds came for growing the plants in Europe. There is a time gap of more than 100 years before this species was collected and placed in an herbarium. Since then it has been collected only a few times, fairly close to the coast from Hawston to just beyond Danger Point, but nowhere near the Cape Peninsula. One wonders if it once grew on the Cape Flats and not having a strong underground rootstock was soon eliminated by mankind. The above description prepared from fresh material amplifies those previously given.

#### SPECIMENS EXAMINED

CAPE—3419 (Caledon): Middelvelei Reserve, Hawston, reclaimed drift sand, Caledon Division (-AC), 8/9/1932, *Hubbard 221* (STE); Die Duine, Wortelgat near

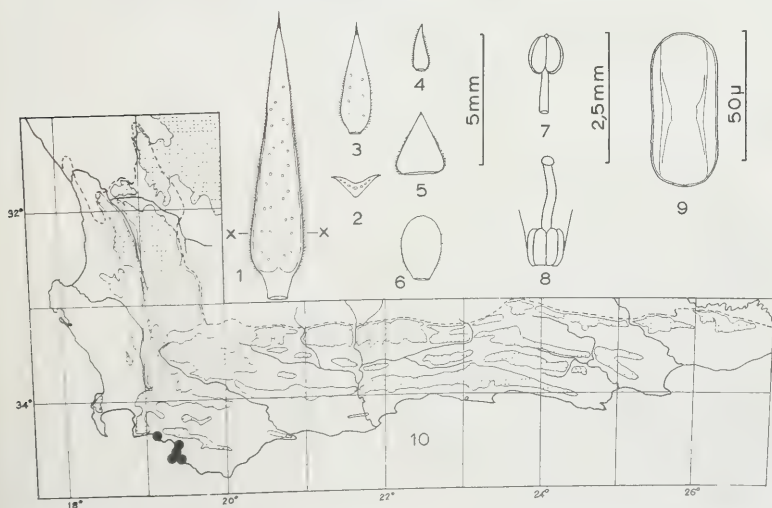


FIG. 14.

*Diosma subulata*: 1, leaf. 2, cross-section of leaf. 3, bract. 4, bracteole. 5, calyx lobe. 6, petal. 7, anther. 8, gynoecium. 9, pollen. 10, distribution.

Hermanus, Caledon Division (-AD), 100 ft., 4/4/1972, *Williams 1635* (NBG, PRE, S, STE), 200 ft., 7/11/1972, *Williams 1721* (NBG), 100 ft., 22/6/1977, *Williams 2311* (NBG); Between Hermanus and Die Kelders near Dadelkom, 1 km from sea, 150 ft., 26/3/1973, *Williams 1776* (NBG, PRE, STE); The Downs, Wolwefontein between Hermanus and Die Kelders, 200 ft., 4/6/1973, *Williams 1815* (NBG, PRE, S); Die Kelders, Caledon Division (-CB), 0-100 ft., 9/11/1962, *Taylor 4290* (PRE, STE); Stanfords Cove/Die Kelders, 50 ft., 20/7/1974, *Williams 1910* (NBG, PRE); Danger Point, -/6/1950, *Lewis 3370* (SAM), 10/6/1950, *B. Maguire 18 and 19* (NBG); near Frikkiesbaai, 24/8/1946, *Leighton 1906* (BOL); 3.8 km E. of bridge over Uilenkraals River on the road to Pearly Beach, Bredasdorp Division (-CB), 100 ft., 3/8/1975, *Williams 2031* (NBG).

Cultivated specimens: (B-W 4790/4), *Hort. Wendland* (BM, C), -/-/1778, *Chelsea Physic Garden 2812* (BM), -/-/1783, *Hort. Paris* (BM), -/-/1786, *Hort. Chapel Allerton* (BM), (LD 108), (LD-ACHAR 100), (W 272, 238).

#### DISTRIBUTION AND VARIATION

*Diosma subulata* has only been recorded from the coastal strip from near Hawston to just beyond the Uilenkraals River. It is never more than about 2.5 km from the sea and grows in sandy soil near stabilised sand dunes. No appreciable variation has been noted but a series of very similar species occur further to the east also growing in sandy soil. They are *D. awilana*, *D. arenicola* and *D. sabulosa*.

*Diosma subulata* is recognised as distinct being a shrub up to 1.5 m tall, single-stemmed at base with leaves subulate, sub-complicate, incurved-erect, ciliate, petiolate; flowers crowded together in reduced racemes; calyx lobes acute and petals glabrous. It differs from *D. awilana* which has leaves sessile and with the mucro sharply reflexed; from *D. arenicola* which has bracts, bracteoles and calyx lobes long crisped-ciliate and from *D. sabulosa* which has leaves ovate.

**10. *Diosma awilana*** Williams in Jl S. Afr. Bot. 41. 4: 255 (1975). Type: CAPE—3419 (Caledon): at base of limestone hills, Awila south of Baard-scheerdersbosch, Bredasdorp Division (-DA), 61 m (200 ft.), 25/5/1973, *Williams 1803* (NBG, holotype; PRE, STE, MO, K, isotypes).

*Diosma awilana* is recognised as distinct on account of its having leaves alternate, sessile, broadly lanceolate with the mucro sharply reflexed and margins crisped ciliate; without any staminodes and with the ovary glabrous. It differs from *D. subulata* which has leaves that are frequently opposite, petiolate and falcate with a straight point. It differs also from *D. sabulosa*, which occurs much further to the east, which has smaller leaves with less hairy margins, with a smaller point at the apex and with smaller flowers. It differs from *D. arenicola* which has leaves less broad and less recurved at the apex, bracteoles much more hairy and twice as long and fruits with much shorter horns.

✓ **11. *Diosma arenicola*** Williams in Jl S. Afr. Bot. **45**: 2: 169 (1979). Type: CAPE—3419 (Caledon): Soetanyenberg above the farm Hangnes, Bredasdorp Division (-DB), 180 m (600 ft.) alt., 25/5/1978, Williams 2507 (NBG, holotype; BOL, K, MO, PRE, S, isotypes).

*Diosma arenicola* is a distinct species with leaves lanceolate with a straight sharp point, with margins crisped ciliate and with the midrib often sparsely pubescent; with bracteoles 4 mm long, linear, crisped ciliate and pubescent along the midrib; and with flowers crowded and sessile. It differs from *D. awilana* which has leaves much broader and more recurved at the apex, bracteoles much less hairy and only half as long and fruits with much longer horns. It also differs from *D. subulata* which is a much more glabrous plant with bracts, bracteoles and calyx lobes short-ciliate not long crisped-ciliate and with flowers in very much reduced racemes not crowded and sessile.

**12. *Diosma sabulosa*** Williams in Jl S. Afr. Bot. **41**: 4: 258 (1975). Type: CAPE—3420 (Bredasdorp): Potberg, in deep sand at base of limestone hills between Buffelsfontein and Cupidoskraal, Bredasdorp Division (-BC), 137 m alt., 22/1/1975, Williams 1955 (NBG, holotype; K, M, MO, PRE, S, STE, isotypes).

*Diosma sabulosa* is recognised as distinct on account of its being a tall plant arising from a single stem; with leaves ovate, alternate, sessile, gland-dotted towards the midrib with thin translucent margins, without staminodes and with petals and ovary glabrous. It differs from *D. echinulata*, from the neighbouring limestone, which is a small scabrous plant with leaves closely spaced, setose-pubescent with a sharp mucro, thick margins and a short petiole, with petals pubescent and with the ovary crowned with short setose hairs. It differs from *D. subulata*, *D. awilana* and *D. arenicola* which have leaves lanceolate or ovate-lanceolate and much longer.

✓ **13. *Diosma pilosa*** Williams in Jl S. Afr. Bot. **41**: 3: 173 (1975). Type: CAPE—3419 (Caledon): on a shoulder of the Riviersonderend mountains due south of Pilarkop near Koksrivier, Caledon Division (-BB), 460 m alt., 13/4/1974, Williams 1892 (NBG, holotype; BOL, C, K, MO, M, PRE, S, STE, isotypes).

*Diosma pilosa* is recognised as a distinct species because it is single-stemmed at the base; has slender branches; adpressed leaves; petals with 2–7 long weak hairs, disc wine-coloured and fruits with very short horns. It is nearest in appearance to *D. meyeriana* but differs in having gland dots scattered on both sides of the midrib instead of one straight row of gland dots on either side of the midrib, flowers less numerous and much larger with petals bearing 2–7 long weak hairs, calyx lobes with much shorter horns spreading rather than erect.



**14. *Diosma oppositifolia* L.**, Sp. Pl. 1: 198 (1753), Esterhuysen in Jl S. Afr. Bot. 9.3: 137 (1943), Williams in Jl S. Afr. Bot. 40.4: 276 (1974). Ico-notype: *Spiraea Africana foliis cruciatim positis*. Fig. 1. Comm. Hort. Med. Amst. (1706).

*Diosma succulenta* Berg., Descr. Plant. Cap.: 63 (1767) excl. syn. Pluk. Type: e Cap. b. sp. *Grubb s.n.* (S-BT).

*Diosma scabra* Lam., Encycl. Meth. Bot. 2: 283 (1786). Type: labelled *Diosma scabra* Lam. Dict. (P-LA).

*Diosma decussata* Lam., Encycl. Meth. Bot. 2: 284 (1786). Type: right hand specimen on sheet labeled *Diosma decussata* Lam. Dict. (P-LA).

*Diosma succulenta* Berg. var. *bergiana* Sond. in Flor. Cap. 1: 373 (1860).

*Diosma carnososa* Solander mss. (BM)-nom. nud.

*Diosma rigidula* Willd., Enum. Plant. Hort. Berol. Suppl.: 12 (1813)-nom. nud.

*Diosma acicularis* Salisb., Prod. Chap. All.: 142 (1796) nom. superfl. Type: As for *D. oppositifolia* L.

*Diosma crassifolia* Hoffmegg., Verz. Pflanz.: 57 (1826)-nom. nud.

*Diosma tetragona* Hort. ex Bartl. & Wendl. Diosmeae in Beitr. Bot. 1: 26 (1824)-nom. nud.

*Diosma succulenta* Berg. var.  $\beta$  *arenaria* Eckl. & Zeyh. Enum. Plant.: 107 (1835)-nom. nud.

*Diosma succulenta* Berg. var.  $\gamma$  *alpina* Eckl. & Zeyh.: 107 (1835)-nom. nud.

Icones: *Spiraea* . . . Comm., Hort. Med. Amst. t.l. (1706); *Diosma succulenta* Wendl., Coll. Plant, t.l. (1805); *Diosma oppositifolia* L. Kidd, Wild Flow. Cap. Pen. pl. 23, fig. 10 (1950); *Diosma oppositifolia* L. Mason, W. Cap. Sandv. Flow. pl, 60, fig. 1 (1972).

*Shrubs* 0,15–1 m tall, erect or sprawling with many stems arising from a stout persistent rootstock. *Branches* fairly slender, glabrous, dark brown, tough, devoid of leaves after about 2 years, tending to become decumbent. *Branchlets* erect, slender, numerous, sparsely puberulous, yellow, leafy. *Leaves* 5–10 mm long, longer in new shoots after fires, 1–1,3 mm broad, narrow-linear, lanceolate or often sub-falcate, glabrous, complicate when dry, opposite, spreading-erect, longer than the internodes, subulate, apex acute with a sharp point or obtuse with a callus, somewhat bent outwards; margins thin, narrowly cartilaginous, sparsely ciliolate; adaxial surface smooth, rather concave, channelled when dry; abaxial surface rounded, gland-dotted to either side, narrowed very slightly at the base; petiole about 0,5 mm long, adpressed. *Inflorescence* terminal with the sessile flowers arising in pairs or sub-terminal-axillary with the *flowers* arising in opposite pairs etc up to eight flowers in a group. *Bract* one to each flower, varying considerably, 2–4,5 mm long, 0,7–1,3 mm broad, lanceolate, acute, ciliolate,

gland-dotted, adaxially flat, round backed, sessile, spreading. *Bracteoles* two, 1,1–2 mm long, 0,5–0,7 mm broad, lanceolate, sub-acute, sessile, glabrous, minutely gland-dotted; margins minutely ciliolate, narrowly translucent. *Calyx lobes* five, 2,3–2,5 mm long, 1,3 mm broad, lanceolate, acute, glabrous; margins minutely ciliolate, narrowly translucent. *Petals* five, 2,9 mm long, 1,8 mm broad, oblong-elliptic, obtuse, sessile, glabrous, white, spreading; margins slightly irregular, partly ciliolate. *Staminodes* none. *Filaments* five, becoming 1,5 mm long, acicular, glabrous. *Anthers* five, before anthesis 1 mm long, 0,7 mm broad, yellow; apical gland globose, sessile, *Pollen* 52  $\mu$  long, 27  $\mu$  broad, oblong. *Disc* sinuate, not much crenulate, green, stands wide open, exceeds the ovary, exudes nectar. *Stigma* 0,25 mm diam., capitellate, green. *Style* deflexed at first becoming 1,2 mm long, erect, glabrous. *Ovary* 5-carpellate, 0,9 mm long, 1 mm diam., glabrous, apices globose, *Fruit* 5-carpellate, 10–12 mm long, 12 mm diam., glabrous, gland-dotted; *horns* truncate or up to 2 mm long, spreading. *Seed* 6,5 long, 3 mm broad, black, shining; aril black.

#### HISTORICAL NOTE

Occurring as it did in the vicinity of Cape Town *Diosma oppositifolia* was one of the earlier species to have been collected at the Cape. It is possible that it was first collected by Oldenland about the year 1692 as listed in Burman's *Prodromus Flora Capensis* published as an addendum to his *Flora Zeylandica* in 1768. Thereafter more gatherings were made by the earlier botanical collectors notably Thunberg, Masson, Oldenburg, Banks & Solander, Roxburgh, Niven, Bowie, Sieber, Sonnerat, Ecklon & Zeyher and Drège. Burchell made no less than six well documented collections of this species. Solander gave it the rather apt manuscript name *Diosma carnosa*. The species depicted by Commelin (1706) was grown in the Amsterdam Medical Garden from seed obtained from the Cape of Good Hope and the original water colour from which the plate was engraved is preserved in the library of the Hortus Botanicus in Amsterdam. The above description prepared from fresh material amplifies those previously given.

#### SPECIMENS EXAMINED

CAPE—3318 (Cape Town): farm Zonquasfontein 12,5 miles from Darling (-AB), 24/6/1968, Boucher 60 (PRE, STE); Springfontein, Malmesbury Division (-CB), 22/1/1971, Axelsson 383 (NBG); Mamre, -/9/1939, Walgate s.n. (BOL); on road to Springfontein Strand near Mamre, 600 ft., 11/8/1977, Williams 2331 (NBG); road to Pella, near Mamre, 700 ft., 25/1/1977, Williams 2267 (NBG); Mamre Road (-BC), 4/8/1946, Leighton s.n. (BOL); Riverlands, Malmesbury Division (-BC/D), 21/9/1977, Esterhuysen 34649 (BOL); in dunis arenosis pone Rondebosch prepe Cape Town infra 100 ped. (-CD), -/6/1879, H. Bolus 1393 (BM); in clivis montis Tabularis supra Orange Kloof, 2 000 ft., 26/6 1892. Schlechter 1034 (BM, GRA. P, W); am Tafelberg, 2 000 ft., 30/4/1826, Drège a (G, K, P, S, W); Tafelberg, 2 000–3 000 ft.,

13/5/1828, *Drège b* (G, P, S, W); Table Mt. lower W. slopes, -/5/1939, *Esterhuysen* 22923 (BOL); Table Mt., Wood Buttress above Bakoven, lower slopes, -/5/1939, *Esterhuysen* 22924 (BOL); N.E slopes of Table Mt., above High Level road, -/6/1940, *Esterhuysen* 22921 (BOL); Table Mt., lower plateau, -/8/1938, *Esterhuysen* 23079 (BOL); Table Mt., lower plateau, near the Wynberg Reservoir, -/5/1938, *Esterhuysen s.n.* (BOL); mountainsides above Kirstenbosch, 17/8/1928, *Hutchinson* 40 (BOL); Kirstenbosch, lower slopes N. of Window Stream, 7/1/1951, *Esterhuysen* 18293 (BOL); sandy slopes N. of Window Stream, 14/4/1956, *Esterhuysen* 25639a (BOL); Kenilworth Race Course, 13/2/1965, *Esterhuysen* 30941 (BOL), 19/2/1970, *Esterhuysen* 32391 (BOL); half a mile S. of Saxonwold turnoff on Mamre Road, Malmesbury Division (-DA), 400 ft., 17/1/1973, *Williams* 1744 (NBG, PRE, STE); on road to Pella Mission near Mamre, 750 ft., 8/9/1975, *Williams* 2066 (NBG); Brackenfel, Stellenbosch Division (-DC), 14/12/1940, *Esterhuysen* 4058 (BOL, GRA, NBG, PRE), -/1/1956, *Loubser* 666 (BOL); between Brackenfel and Kraaifontein, 28/11/1972, *Esterhuysen* 33052 (BOL), 12/4/1977, *Burgers* 421 (Nat. Cons. Herb.); near Mamre turnoff on National Road to Malmesbury, 237 ft., 28/8/1973, *Williams* 1857 (NBG); Monte Vista, 20/19/1965, *Esterhuysen* 31302 (BOL); In sabulosis (Altit. 1) *Planitiei Capensis* prope Doornhooft, -/1/-, *Ecklon & Zeyher* 839  $\beta$  *arenaria* (C, G, PRE, S, SAM, W).

—3148 (Simonstown): in collibus circa Simonstown bay (-AB), -/10/1801, *Robert Brown s.n.* (BM); near Constantia, 1/1/1896, *Wolley Dod* 728 (BM, BOL); sandy plains, Wynberg, *Niven* 30 (BM); Claremont flats prope Wynberg, 22/1/1892, *Schlechter* 229 (C, G, GRA, P, W); Kalk Bay Mt., 500 ft., -/12/1913, *F. Bolus s.n.* (BOL), 1 000 ft., 1/8/1976, *Goldblatt* 3700 (MO); Inhoffs Gift, Cape Peninsula, -/8/1939, *Esterhuysen* 22920 (BOL); Slangkop, -/7/1939, *Esterhuysen* 22909 (BOL); in lapidosis summi montis Muizenberg, c. 1 000 ft., -/9/1882, *MacOwen* HNAA 205 (BOL); Hout Bay on the N. slopes of the Sentinel, 500 ft., 28/8/1973, *Williams* 1855 (NBG); Hout Bay, slopes of Table Mt., below Groot Kop, 21/3/1942, *Esterhuysen* 22922 (BOL), *Esterhuysen* 23084 (BOL); S. end of Table Mt., slopes above Constantia Nek, 4/5/1952, *Esterhuysen* 20097 (BOL); Bonteberg, Southern Peninsula, 12/8/1940, *Esterhuysen* 22908 (BOL); near Smitswinkel, Cape Peninsula (-AD), 1 300 ft., 26/4/1940, *Compton* 8710 (NBG); Cape Point Nature Reserve, Brightwaters, 25/2/1980, *Bean* 353 (BOL), 21/1/1948, *Rodin* 3298 (BOL); Zeekoevlei (-BA), -/7/1938, *Esterhuysen s.n.* (BOL); Steenbras River Mouth, rocky ground near the sea (-BB), 23/3/1946, *Parker* 4039 (NBG); in terra ericeta (altit. IV, V) laterum montium Hottentotshollandberge, -/4/-, *Ecklon & Zeyher* 839  $\gamma$  *alpina* (SAM); Kogelberg Reserve, S.W. slopes of the Paardeberg, Caledon Division (-BD), 600 ft., 7/1/1970, *Boucher* 1023 (PRE, STE); Kogelbay, 15/12/1946, *Leighton* 2470 (BOL).

—3419 (Caledon): Palmiet River, Caledon Division (-AA), 1 200 ft., 4/2/1896, *Schlechter* 7324 (BM, G, GRA, S, W); on the mountain of the Niewekloof, 18/3/1815, *Burchell* 8094 (K); in collibus Grabouw prope Palmiet River, -/12/1897, *H. Bolus* 4119 (BOL); in lateribus montium Hottentotshollandberge prope fluvium Palmiet River, altit. III, (-/6/-), *Ecklon and Zeyher* 838 (C, G, P, SAM, W); in collibus prope Caledon (-AB), -/1/1901, *H. Bolus* 9216 (BOL); at foot of Onrust River Mountain (-AC), 20/2/1941, *Esterhuysen* 4906 (BOL, NBG, PRE), 28/2/1925, *Compton* 3370 (BOL); Onrust River above Hemel en Aarde road, 1/12/1951, *Esterhuysen* 19257 (BOL); Fernkloof, Hermanus, Caledon Division (-AD), 300 ft., 6/8/1971, *Williams* 1499 (NBG, PRE), 800 ft., 5/10/1971, *Williams* 1543 (NBG); Hermanus mountain above the Golf Course, 850 ft., 7/8/1971, *Williams* 1504 (NBG); Weltevreden, N. of Stanford, 350 ft., 30/8/1971, *Williams* 1523 (NBG); lower slopes of Klein River Mtns., -/9/1940, *Esterhuysen* 2911 (BOL), 500 ft., 18/5/1941, *Stokoe* 9150 (BOL); Zondagskloof, Caledon Division (-BC), 29/12/1940, *Compton* 10227 (NBG); Duinefontein near Gansbaai, Bredasdorp Division (-CB), 7/1/1962, *Rycroft* 2383 (NBG);

between Gansbaai and Stanford, roadside, Caledon Division, 29/12/1940, Walgate 89 (BOL); slopes of Gunners Quoin near Ratel River, Bredasdorp Division (-DA), 10/2/1958, Lewis 5259 (SAM); Awila, S. of Baardscheedersbos, 50 ft., 25/5/1973, Williams 1804 (BG); south of Napier, Bredasdorp Division (-DB), 18/2/1951, Compton 22653 (NBG, S).

Without precise locality: *D. obtusata* (B-W 4785.1), *D. oppositifolia* Thunberg (B-W 4789.1), *D. succulenta* 1. (B-W 4798.1), *D. succulenta* 2. (*Diosma rigidulum et succulentum*) (B-W 4798.2), *Diosma carnosa* Sol. Promont. B. Spei, 1771, Banks and Solander s.n. (BM, C, LINN 270/2), *D. scabra*, Sonnerat s.n. (P, P-LA), *D. decussata*, Sonnerat s.n. (P, P-LA); Sparrman s.n. (LINN), e Cap. b. Spei. Thunberg 5714 (UPS), 5715 (UPS), Masson s.n. (BM), Roxburgh s.n. (BM), 1772, Oldenburg 243 (BM), Bowie s.n. (BM), Masson s.n. (BM), Sieber 65, 193, 194 (P), 1848, Boivin 743 (BOL, P).

#### DISTRIBUTION, VARIATION AND HYBRIDISATION

*Diosma oppositifolia* is found growing on flats or mountains in sandy soil derived from the quartzitic rocks of the Table Mountain geological series at altitudes of up to 700 m (2 300 ft.). Being a plant with a persistent rootstock from which it regenerates after fires it does not appear to form dense colonies and, although seed is fairly liberally produced, seedlings are very seldom seen. This species is distributed along a more or less N.W.-S.E. axis from Zonguasfontein north of Darling to Gunners Quoin near Quoin Point in the south with perhaps the main concentration being found on the Cape Peninsula towards the middle of its range.

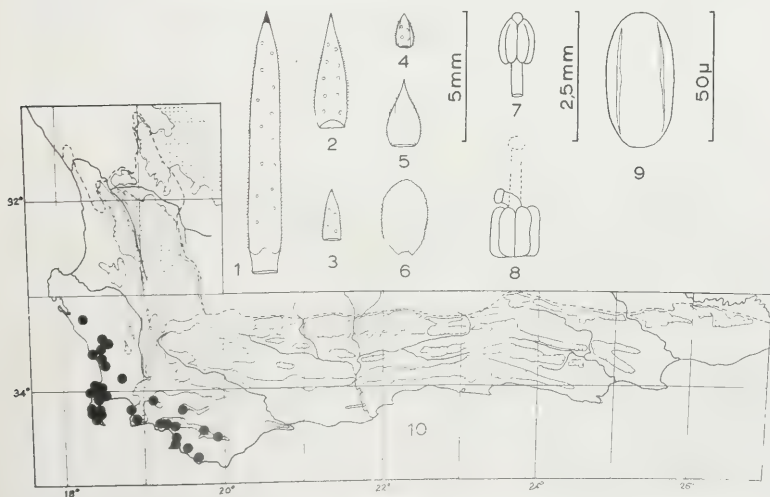


FIG. 15.

*Diosma oppositifolia*: 1, leaf. 2, large bract. 3, small bract. 4, bracteole. 5, calyx lobe. 6, petal. 7, anther. 8, gynoecium. 9, pollen. 10, distribution.



When regenerating after fires the vigorous shoots may produce leaves opposite, alternate, or 3-nate. Plants found growing on the sandy flats towards the north west have leaves that are thicker with the mucro more obtuse. Fruits from plants towards the south east have slightly longer horns. Successively smaller leaves and branchlets are produced each season as the plant ages.

Hybridisation is extremely rare but the following putative hybrids with *Diosma hirsuta* L. have been observed:

Steenbras Siding, Caledon Division, -/7/1940, *Esterhuysen* 2685 (BOL); Onrust River above Hemel and Aarde road, Caledon Division, 1/12/1951, *Esterhuysen* 19275a (BOL).

*Diosma oppositifolia* is a distinct species being a shrub usually low with many stems arising from a persistent rootstock; with leaves either elliptic-lanceolate obtuse with a small blunt callus or linear-lanceolate acute with the apex recurved with a small sharp mucro, complicate when dry, spreading-erect, normally opposite; with flowers sessile aggregated up to 8 in pairs, with no staminodes; with anthers bearing a sessile apical gland and with seeds shining, relatively large. *Diosma dichotoma*, the only other species of *Diosma* with opposite leaves and no staminodes, is distinguished by having much smaller leaves and the anther-gland sub-stipitate. From *Diosma subulata*, a tall species, single-stemmed at base, with leaves either opposite or alternate, *D. oppositifolia* is distinguished by its many stemmed habit and lower growth.

**15. *Diosma dichotoma* Berg.**, Descr. Plant. Cap.: 63 (1767). Type: *Diosma mihi dichotoma e Cap. b. Sp. Grubb* (Berg. Scrips.) (S-BT, holotype; C, isotype).

Non *Diosma cupressina* L., Mant.: 50 (1767) which from the description, in the absence of type material, belongs most probably in the *Bruniaceae*.

Icones: *Diosma cupressina* Wendl., Coll. Plant. 2:59, Tab. 61 (1810); Lodd., Bot. Cab. 4: 303, tab. 303 (1819); *Diosma dichotoma* Berg. Mason, W. Cap. Sandv. Fls.: 142, pl. 60, fig. 3 (1972).

Shrubs 0,5-0,6 m tall, spreading 1 m diam., forming a dense rounded bush with many stems arising from a stout underground root-stock. Branches fairly erect, glabrescent, greyish-brown, roughened with leaf scars. Branchlets numerous, erect, slender, minutely puberulous, reddish-brown where exposed, dichotomous or opposite. Leaves 1,5-4 mm long, 1,1-1,4 mm broad, lanceolate, acute opposite, decussate, adpressed-erect, sessile; hyaline margins narrow, minutely ciliolate; apex minutely callused; midrib fairly prominent; abaxial surface with large scattered gland dots. Inflorescence terminal, 1 to 3-nate, normally 2-nate, sessile, 8 mm diam., star-like, white; calyx thinly puberulous. Bract one to each flower, 1,8 mm long, 1,3



mm broad, ovate-lanceolate; apex with an elevated point; hyaline margins ciliolate; adaxial surface pubescent in the middle; abaxial surface gland-dotted, scabrid. *Bracteoles* two, 1,9 mm long, 0,9 mm broad, lanceolate, somewhat minutely pubescent on all sides, apex echinulate with a minute point; hyaline margins ciliolate; abaxially gland-dotted to either side of the midrib. *Calyx lobes* five, 2,4 mm long, 1,4 mm broad, deltoid-lanceolate, acute with an elevated sub-echinulate point; hyaline margins broad below, pinkish coloured, ciliolate; adaxial surface puberulous; abaxial surface scabrid-puberulous, gland-dotted. *Petals* five, 3,6-3,8 mm long, 1,5-1,8 mm broad, oblong-lanceolate, acute, spreading widely; margins irregular, semi-translucent, very sparsely and minutely ciliolate, later curling inwards above; midrib slightly raised at the apex, one or two small gland dots. *Staminodes* absent. *Filaments* five, 2 mm long, acicular, glabrous. *Anthers* five, before anthesis 1,4 mm long, 0,7 mm broad, yellow; apex tapering to a recurved gland which exudes a droplet of nectar in the angle for the curve. *Pollen* 58  $\mu$  long, 28  $\mu$  broad, oblong. *Disc* stands wide open, sinuate-crenulate, green, minutely dimpled, exudes nectar, exceeds the ovary by a long way. *Stigma* 0,3 mm diam., capitellate, globose. *Style* becoming almost 2 mm long, glabrous, deflexed at first. *Ovary* 5-carpellate, 0,7 mm long, 0,8 mm diam., glabrous except for a few minute hairs around the globose apices of the carpels. *Fruit* 5-carpellate, 7,5 mm long, 7,5 mm diam.; *carpels* glabrous, abaxially dimpled with sunken oil glands; apex truncate, virtually hornless, radially narrowly cleft with an immersed gland at the outer end. *Seed* 5,7 mm long, 2,4 mm broad, black, shining; aril small, black at base.

A careful study of the description of the species *Diosma cupressina* L. reveals that it could not refer to the species *Diosma dichotoma* Berg. There are three obvious characteristic differences: leaves alternate, calyx membranaceous and petals clawed, whereas the species *D. dichotoma* has leaves opposite, calyx quite substantial and petals sessile. It is possible that the species *D. cupressina* L. is *Thamnia uniflora* Solander ex Brongniart (vide Sheet No. 270/23 in Linnaeus' Herbarium), a very rare plant that has seldom been collected. On the other hand *D. dichotoma* has been quite frequently collected in the vicinity of Cape Town. One may therefore understand how the more commonly found and superficially similar plant became attached to the wrong name. This error has in the past been perpetuated by many authors who have simply copied one another. The above description based upon fresh material amplifies those given by previous authors in describing what they thought to be *D. cupressina*.

#### SPECIMENS EXAMINED

CAPE—3318 (Cape Town): Coeratenberg near Hopefield (-AB). -/1887. *Baccharis* 5968 (BOL); a few miles along the road to Langebaan from the Darling to



FIG. 16.

Flower of *Diosma dichotoma* with petal removed showing the reflexed anther gland.

Ysterfontein road (-AC), 3/5/1972, *Esterhuysen s.n.* (BOL, S); Malmesbury Division near Bokbaai (-CB), 15/9/1940, *Esterhuysen 18873* (BOL, PRE), 21/7/1976, *Williams 2184* (NBG), 25/1/1977, *Williams 2264* (NBG); road to Melkbosch Strand near turn-off from main road -/7/1940, *Esterhuysen 4365* (BOL), 23/9/1951, *Esterhuysen 18873* (BOL, PRE); Flats near Vygieskraal (-DC), 29/12/1895, *Wolley Dod 727* (BM); near Doornhoogde, 25/12/1896, *Wolley Dod 2197* (BOL); in the Cape Downs on the road between Luyaardsfontein and Salt River, 13/4/1815, *Burchell 8381* (GOET, K, P, SAM, W); Sandhills between Cape Town and Stellenbosch, 200 ft., (III, E. b), 29/4/1828, *Drège 7150* (P, S); Damp flats between dunes and railway embankment near

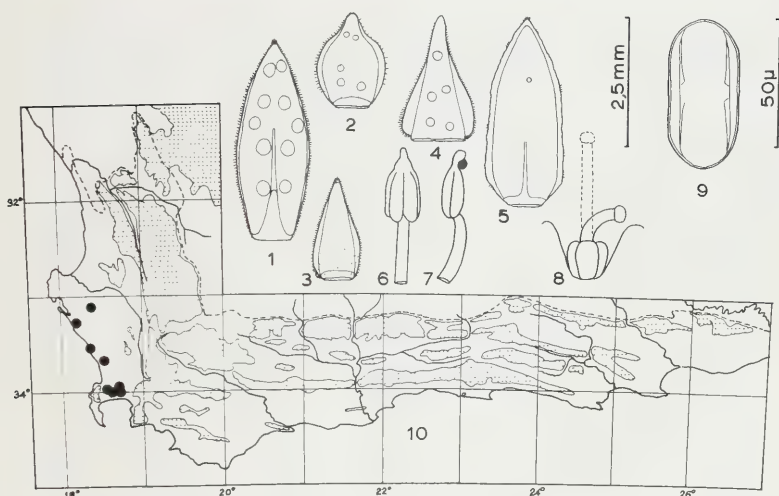


FIG. 17.

*Diosma dichotoma*: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, anther. 7, side view of anther with droplet of nectar. 8, gynoeceium. 9, pollen. 10, distribution.

Sarepta, 22/12/1932, Acocks 1239 (S); in plains at Klipfontein, -/11/-, Zeyher 290 (BOL, K, S).

—3418 (Simonstown): Cape Flats 2 miles W. of Faure (-BA), 19/1/1934, Salter 4249 (BM, BOL, PRE), 9/1/1934, Galpin 12713 (PRE); Isoetes Vlei, Cape Flats, 13/1/1969, Matthews 40 (NBG); In sandy Cape plains near Hottentotsholland, -/6/-, Ecklon & Zeyher 853 (C, GOET, LD, P, PRE, S, SAM, W).

Without precise locality: *Diosma mihi dichotoma* e Cap. b. Sp. Grubb (S-BT, C), Masson s.n. (BM), Roxburgh s.n. (BM), Mund s.n. (K).

The locality "on moist hills of George and Swellendam" given by Bowie s.n. (BM) is extremely dubious.

#### DISTRIBUTION AND VARIATION

*Diosma dichotoma* is found growing on the sandy plain from near Faure in the south to near Hopefield in the north, usually fairly close to the sea coast.

No significant variation has been observed.

*Diosma dichotoma* is recognised as distinct being a dense shrub up to 0.6 m tall, spreading to 1 m in diam. with leaves 1.5-4 mm long, lanceolate-acute, sessile, adpressed, opposite, with anthers tipped with a sub-stimate reflexed gland and with fruits truncate, hornless. *D. oppositifolia*, the only other species of *Diosma* with opposite leaves and no staminodes, is distinguished by having much larger leaves and a sessile apical anther-gland.

2. **DIOSMA** sectio **TUMELLA** Williams, sect. nov. propria propter florem staminodiis vestigialibus. Type: *D. prama* Williams.

Section *Tumella* is distinguished in having the flower with vestigial staminodes.

16. *D. aristata*
17. *D. rourkei*
18. *D. thyrsophora*
19. *D. tenella*
20. *D. recurva*
21. *D. prama*
22. *D. echinulata*
23. *D. guthrei*
24. *D. haelkraalsensis*
25. *D. demissa*
26. *D. apetala*
27. *D. passerinoides*
28. *D. strumosa*

**16. *Diosma aristata*** Williams in Jl S. Afr. Bot. 41.3: 180 (1975). Type: CAPE—3422 (Mossel Bay): On the north slopes of a hill about 2,5 km east of Mossel Bay near the reservoir (-AA), 170 m alt., 6/5/1974, *Williams 1902* (NBG, holotype; BOL, C, GRA, K, MO, M, PRE, S, STE, isotypes).

*Diosma aristata* is recognised as distinct on account of being a plant rising from a single stem at the ground with very large aristate alternate leaves, and completely glabrous except for the apices of the horns on the fruits.

**17. *Diosma rourkei*** Williams in Jl S. Afr. Bot. 41.3: 176 (1975). Type: CAPE—3324 (Steytlerville): Baviaanskloof, on the Piskoedvlakte about 2 km from the farm Goedehoop on the road to Willowmore, Humansdorp Division (-CB), 550 m alt., 18/6/1974, *Rourke 1416* (NBG, holotype; BOL, C, GRA, K, M, MO, PRE, S, STE, isotypes).

*Diosma rourkei* is a distinct species being an erect shrub up to 2 m tall, single-stemmed for 250 mm at the base with branches crowded into small tufts, leaves linear-lanceolate acute, the flowers aggregate, petals sessile and the style always erect. It differs from *D. thyrsophora* which has leaves obtuse, petals narrowing to the base and the style at some stage deflexed.

**18. *Diosma thyrsophora*** Eckl. & Zeyh., Enum. plant.: 107 (1835). Type: In solo ericeto (altit. 4,5) laterum montium prope fluvium Rivierzonderend supra villam Knoblauch (Swellendam), Febr. Mar. *Ecklon & Zeyher 840* (S, lectotype; C, S, SAM, isotypes).

*Shrubs* up to 3 m tall arising from a single stem towards the base, (one plant 2,8 m tall, measuring 29 mm diam. at the base, showed about 19 growth rings); bark brown, becoming rough with horizontal scars. *Branches* erect, fairly slender, glabrous, brownish-red, the outer skin splitting off, often dividing irregularly in twos. *Branchlets* somewhat tufted, very slender, numerous, glabrous, spreading, alternate, yellowish, leafy, many eventually dying back and falling off. *Leaves* 4,5–6,5 mm long, 1–1,5 mm broad, much smaller on floral branchlets, linear-lanceolate, obtuse, glabrous, sessile, spreading-erect, alternate; margins eciliate, narrowly translucent with a few smaller immersed gland dots; midrib not prominent with gland dots scattered to either side; adaxially flat when fresh. *Inflorescence* terminal on very short branchlets, 1, 2 or rarely 3-nate; *flowers* 6 mm diam., pedicellate; petals white, widely spaced. *Bract* 0,9–1,4 mm long, 0,5 mm broad, deltoid or lanceolate, obtuse, glabrous, gland-dotted; apex glandular; margins below very narrowly translucent and sub-ciliate. *Bracteoles* two, 0,9 mm long, 0,5 mm broad, oblong-lanceolate, obtuse, glabrous, 1 or 2 gland-dotted; apex thickened, glandular; margins translucent, very sparsely ciliate below. *Calyx lobes* five, about 1,2 mm long, 1 mm broad, sub-orbicular, obtuse, glabrous, 3–4 gland-dotted; apex thickened, rather curled inwards; margins broadly translucent, sparsely ciliate; supports the reflexed anthers before anthesis. *Petals* five, 2,3–2,6 mm long, 1,3–1,4 mm broad, oblong, obtuse, glabrous except for one or perhaps two long hairs on the adaxial surface, narrowing below to a short claw, white, soon delapsing; margins rather irregular with one or two setae. *Staminodes* five, a spherical gland at the outer edge of the disc, about 0,1 mm diam., becoming 0,2 mm long after the filaments have delapsed, persisting. *Filaments* five, becoming 1,5 mm long, acicular, pale, glabrous. *Anthers* five, 0,9 mm long, 0,7 mm broad, before anthesis, orange-coloured; apical gland pink, deflexed inwards. *Pollen* 57  $\mu$  long, 27  $\mu$  broad, oblong. *Disc* sinuate-crenulate, stands wide open, pink, exudes nectar. *Stigma* 0,25 mm diam., globose, green, capitellate, becoming sticky. *Style* becoming 1,6 mm long, terete, glabrous, purplish, deflexed at some stage. *Ovary* 5-carpellate, 0,8 mm diam., 0,7 mm long, glabrous; apices globose, green. *Fruit* 5-carpellate, 10 mm long, 8 mm diam., base pointed 1,5 mm long; carpels very pale green, glabrous, gland-dotted; *horns* very short, spreading, apex immersed-glandular. *Seed* 5–6 mm long, 2,5–3 mm broad, black, shining; aril black with a few stripes.

*Diosma thyrsophora* was discovered by Zeyher in the Riviersonderend Mountains above the farm of Mr. Knoblauch whose descendants are still farming in this area. *D. thyrsophora* and *D. recurva* were regarded by Sonder (1860) as being conspecific but *D. thyrsophora* is a much taller plant with branchlets more numerous and more slender, with leaves linear-lanceolate not elliptic or oblong with petals without gland dots and with the calyx glab-



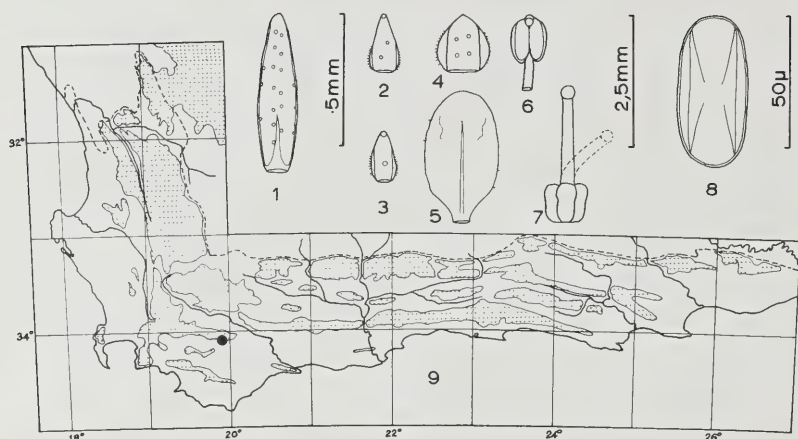


FIG. 18.

*Diosma thyrsophora*: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, anther. 7, gynoecium. 8, pollen. 9, distribution.

rous not pubescent. The above description prepared from fresh material amplifies those previously given.

#### SPECIMENS EXAMINED

CAPE—3419 (Caledon): In solo ericeto (altit. 4,5) laterum montium prope fluvium Riviersonderend supra villam Knoblauch (-BB), Feb. Mar., *Ecklon and Zeyher* 840 (S, C, SAM); Riviersonderend, -/10/1940, *Stokoe* 9012 (BOL); in kloof near Riviersonderend, 12/2/1956, *Esterhuysen* 25335 (BOL); upper slopes Riviersonderend peak, 3 000 ft., -/11-12/1928, *Thorne s.n.* (SAM); Riviersonderend Mtns., Olifantskloof near Municipal weir, 800 ft., 5/5/1971, *Kruger* 1242 (STE); Olifantskloof at the third weir, Riviersonderend, 700 ft., 22/4/1975, *Williams* 1992 (NBG), 25/10/1975, *Williams* 2130 (NBG).

#### DISTRIBUTION

*Diosma thyrsophora* appears to be confined to the mountains to the north of the town of Riviersonderend.

No variation has been observed.

*Diosma thyrsophora* is a distinct species growing up to 3 m tall, totally glabrous, single-stemmed at base with branchlets numerous, very slender, somewhat clustered, with leaves linear-lanceolate, obtuse, sessile, alternate, gland-dotted along either side of the midrib and on margins, with petals with one or two scarcely discernible hairs about the middle, narrowing below to a short claw and with the anther gland deflexed.

**19. *Diosma tenella* Williams, sp. nov. propria propter semen testa rugosa.**

*Frutex* 0,3–0, m altus, erectiuculus, ad basim monocaulis. *Rami* brevi, gracili, sparsim puberuli, rubescenti. *Folia* 5,1–7,1 mm longa, 0,8–0,9 mm lata, lineari-oblonga, obtusa, glabra, eciliata, alterna, glanduloso-punctata, minute albo-mucronata. *Inflorescentia* solitaria, terminalia, reducto-racemosa; flos 5 mm diam., calyx puberulus. *Bractea* 1,5–2,4 mm longa, 0,6–0,7 mm lata, lanceolata, sub-obtusa, glabra, glanduloso-punctata, marginibus sparsim ciliolatis. *Bracteolae* duae, 0,7 mm longae, 0,6 mm latae, orbiculares, crassius culae, intus minute puberulae, extus glabrae glanduloso-punctatae. *Sepala* quinque, 1 mm longa, 1 mm lata, sub-orbicularia, crassiuscula, intus puberula, extus glabra glanduloso-punctata, marginibus minute ciliolatis anguste translucientia. *Petala* quinque, 2,2 mm longa, 1,5–1,6 mm lata, ovata, obtusa, sessilia, glabra, alba, glanduloso-punctata, sub-rosea. *Staminodia* quinque, 0,1 mm diam., globosa, vestigialia. *Filamenta* quinque, 1,7 mm longa, glabra. *Antherae* quinque, ante anthesin 1 mm longae, 0,7 mm latae, floridae, glandula globosa semi-immersa coronata. *Pollen* 46  $\mu$  longum, 22  $\mu$  latum, ellipsoideum. *Discus* sinuato-crenulatus, viridus, patens, ovarium excedens. *Stigma* 0,15 mm diam., viridum, capitellatum. *Stylus* prima deflexus deinde 1,1–1,8 mm longus, glaber, longe persistens. *Ovarium* 5-carpellatum, 0,5 mm longum, 0,7 mm diam., glabrum, viridum, apicibus globosis. *Frucuts* 5-carpellatus, 5 mm longus, 7 mm diam., glaber, multi-glanduloso-punctatus, rubescens; cornua 1 mm longa, obtusa, immerso-gladulosa coronata. *Semen* 3–3,5 mm longum, 1,8–2 mm latum, piceum, rugosum.

*Type:* CAPE—3420 (Bredasdorp): Bredasdorp/Skipskop road 23 km from Bredasdorp at boundary of farms Moerasfontein and Uyshoek (-CB), 12 m (40 ft.) alt., 20/6/1979, Williams 2781 (NBG, holotype; BOL, K, MO, PRE, S, isotypes).

*Shrubs* 0,3–0,4 m tall, fairly erect, spreading 0,5 m or more, diffuse, in this locality single-stemmed at base. *Branches* spreading, variously bent, glabrous; bark smooth, ashy-brown. *Branchlets* short, fairly erect, slender, thinly puberulous, reddened, not hidden by the leaves. *Leaves* 5,1–7,1 mm long overall, 0,8–0,9 mm broad, linear-oblong, obtuse, glabrous, eciliate, short-petiolate, alternate, spreading or somewhat erect; apex minutely whitish-mucronate; abaxial surface convex, lumpy with gland dots to either side of the midrib. *Inflorescence* solitary, terminal in very much reduced racemes; buds pink; *flowers* 5 mm diam., calyx puberulous. *Bract* varies in size, 1,5–2,4 mm long, 0,6–0,7 mm broad, lanceolate, sub-obtuse, glabrous, gland-dotted; margins very sparsely ciliolate, not translucent. *Bractlets* two, 0,7 mm long, 0,6 mm broad, orbicular, quite thick; adaxial surface minutely pubescent; abaxial surface glabrous, gland-dotted; margins minutely ciliolate, very narrowly translucent. *Calyx lobes* five, 1 mm broad, 1 mm

long, sub-orbicular; adaxial surface concave, minutely pubescent; abaxial surface glabrous, gland-dotted; margins minutely ciliolate, narrowly translucent. *Petals* five, 2,2 mm long, 1,5–1,6 mm broad, ovate, obtuse, sessile, white, glabrous, abaxially gland-dotted, flushed with pink. *Staminodes* five, 0,1 mm diam., a spherical gland at the base of the petal on the outside of the disc. *Filaments* five, becoming 1,7 mm long, glabrous, acicular. *Anthers* five, before anthesis 1 mm long, 0,7 mm broad, yellow; apical gland globose semi-immersed. *Pollen* 46  $\mu$  long, 22  $\mu$  broad, ellipsoid. *Disc* sinuate-crenulate, green, stands open, exceeds the ovary. *Stigma* 0,15 mm diam., capitellate, green. *Style* deflexed at first becoming 1,3–1,8 mm long, glabrous, persisting for some time. *Ovary* 5-carpellate, 0,5 mm long, 0,7 mm diam., glabrous green, apices globose. *Fruit* 5-carpellate, 5 mm long, 7 mm diam., glabrous, multi-gland-dotted, reddened in the grooves between the carpels and below; *horns* 1 mm long, very short, obtuse; apex with a deeply immersed gland. *Seed* 3–3,5 mm long, 1,8–2 mm broad, black, minutely wrinkled, not shining except when magnified; aril dirty brown.

It would seem that this plant was first discovered by Burchell on the 27th November 1814 "on the road over the mountains from our station at Klein Vette River to our station at the foot of the Great Southern Range at Mountain Station". This locality lies to the north of Riversdale towards Garcia Forest Station. It was collected by Muir in 1908 on the Riversdale commonage and again by Esterhuysen in 1950 at Garcia Forest Station. Recent searches in this area have failed to rediscover this species. Fortunately it has now been found growing in several places in the Bredasdorp District by Mr. Chris Burgers whose keen interest and observations in this connection are very much appreciated.

#### SPECIMENS EXAMINED

CAPE—3220 (Montagu): Strawberry Hill, Langeberg, Heidelberg Division (-DD), -/12/1954, *Stokoe s.n.* (SAM 68917).

—3420 (Bredasdorp): De Hoop-Potberg Nature Reserve, flats, course of Pottebergsvier, 4 km. W.S.W. of Potberg buildings, Bredasdorp Division (-AD), 110 m, 21/6/1979, *Burgers 1980* (STE); Melkbosheuwel, 4 km W. of Potberg Residence, 120 m, 19/8/1980, *Burgers 2457* (STE); On the road between Zuurbraak and the ford (at Sibilljes) through Buffelsjagts River (the drift), Swellendam Division (-BA), 4/1/1815, *Burchell 7269* (K); De Hoop-Potberg Nature Reserve, 3,5 km. S.E. of Potberg homestead (-BC), 500 ft., 13/8/1980, *Williams 3046* (NBG, PRE), 150 m, 18/1/1979, *Burgers 1693* (STE), 180 m, 18/8/1980, *Burgers 2455* (STE); Bredasdorp/Skipkop road 23 km from Bredasdorp at boundary of Farms Moerasfontein and Uyshoek (-CB), 10 m, 17/6/1979, *Burgers 1886* (STE), 12 m (40 ft.), 20/6/1979, *Williams 2781* (NBG, BOL, K, MO, PRE, S), 13/8/1980, *Williams 3050* (NBG, BOL, MO, PRE).

—3421 (Riversdale): on the road over mountains from our station on Klein Vette River to our station at the foot of the Great Southern Range at "Mountain Station" (-AA), 27/11/1814, *Burchell 6860* (K); Riversdale Commonage, -/12/1908, *Muir 41*

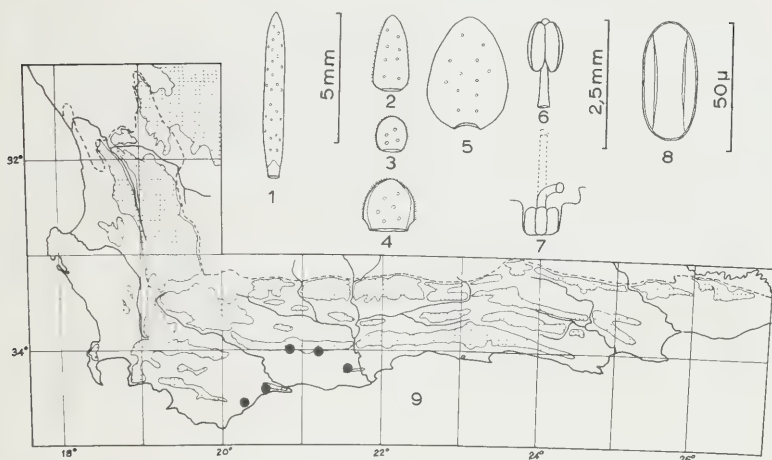


FIG. 19.

*Diosma tenella*: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, anther. 7, gynoecium. 8, pollen. 9, distribution.

(SAM 6681); Slopes of Langebergen at Garcia Forest Station, Riversdale Division, 25/5/1950, *Esterhuysen 17241* (BOL); Near Albertinia, Riversdale Division (-BA), 20/1/1951, *Compton 22594* (NBG).

#### DISTRIBUTION AND VARIATION

*Diosma tenella* is found growing on sandy soils associated with a variety of geological formations including Bokkeveld shales, ferricrete, silcrete and gravels. It occurs fairly near the coast in the Bredasdorp Division, on the foothills of the Langebergen near Heidelberg and Riversdale and at Albertinia. It appears to be rather rare, having been very seldom collected.

A certain amount of variation appears to occur. Whilst plants in the type locality appear to be single-stemmed at base, those in other localities seem to be able to resprout after fires. Some populations have leaves rather erect with apices obtuse and others have the leaves spreading, of a lighter colour, and more acute. The leaves of a specimen from Strawberry Hill have a rather knotty appearance with the glands deep set but in other populations this character is not so obvious. It was noticed that the leaves of those populations examined in a fresh state gave off a very distinctive smell reminiscent of fresh red bait (ascidian) when crushed regardless of any variation in appearance.

*Diosma tenella* is recognised as distinct because of having *leaves* small, linear, mucronate, multi-gland-dotted, with the midrib slender and with cartilaginous margins very narrow; *petals* gland-dotted. Moreover this is the only species of the *Diosmeae* so far encountered that has the seed surface wrinkled rather like a fingerprint.

The name was that used by Burchell on the ticket attached to his specimen No. 6860.

**20. *Diosma recurva*** Chamisso in Linnaea **5**: 51 (1830). Type: Congo, -/5/1819, Mundt and Maire s.n. (S, lectotype).

*Diosma ericoides* sensu L., Sp. Pl. ed. 2.1: 287 (1762).

Non *Diosma ericoides* L., Sp. Pl. **1**: 198 (1753). Type: Pluk. Phytogr. t. 279. f. 5 (1696), iconolectotype. See also Williams in J1 S.Afr. Bot. **47**:1: 79 (1981).

*Shrubs* 0.7–1 m tall, single-stemmed at base, pale green in appearance. *Branches* erect, forked; bark grey, fairly smooth. *Branchlets* erect, numerous, slender, yellowish-green, thinly puberulous, leafy. *Leaves* up to 3.5 mm long, 2 mm broad, elliptic, obtuse, glabrous, alternate, 5-ranked, short-petiolate, spreading, slightly reflexed; apex with an immersed gland; margins gland-dotted, very sparsely and minutely ciliolate mainly below; adaxial surface dark green, smooth, fairly flat; abaxial surface gland-dotted along the midrib. *Inflorescence* solitary in terminal and sub-terminal clusters, sessile on very short branchlets. *Bract* one, about 1.5–1.75 mm long, 1–1.4 mm broad, deltoid, obtuse, ciliolate; adaxial surface concave, slightly pubescent below; abaxial surface thinly puberulous below; midrib raised, gland-dotted. *Bract-eoles* two, 1.2–2 mm long, 0.75–1 mm broad, elliptic, obtuse, ciliolate; adaxial surface concave, puberulous in the hollow; abaxial surface sparsely puberulous below, gland-dotted along the midrib. *Calyx lobes* five, 1.5 mm long, 1.5 mm broad, oblong-deltoid, obtuse, ciliolate; adaxial surface flat, puberulous; abaxial surface sparsely puberulous below, gland-dotted along the midrib. *Petals* five, 2–2.3 mm long, 1.5–2 mm broad, ovate or sub-quadrangular, obtuse, very sparsely ciliolate, white, glabrous, somewhat connate with the disc; abaxial surface gland-dotted towards the midrib. *Stam-inodes* five, 0.2–0.3 mm long, glandular at the apex, arising towards the outer edge on the summits of the disc. *Filaments* five, becoming 1.8 mm long, acicular, glabrous. *Anthers* five, before anthesis 0.8 mm long, 0.7 mm broad, yellow or reddish tinged with orange; apical gland globose, pointing inwards. *Pollen* 53  $\mu$  long, 25  $\mu$  broad, obloid. *Disc* 5-lobed, 2 mm diam., double the height of the ovary, forming a cup, edges thickened, nectariferous, olive green. *Stigma* 0.15 mm diam., globose, capitellate. *Style* may be deflexed at some stage becoming erect, 1.6 mm long, glabrous. *Ovary* 5-carpellate, 0.9 mm long, 0.8 mm diam., lobes obtuse, glabrous, green. *Fruit*



5-carpellate, each carpel 6–9 mm long with horn 2–4 mm long, glabrous, gland-dotted. Seed 5–8 mm long overall, 2–3 mm broad, black, shining; aril white.

The specimen of *D. recurva* in Linnaeus' herbarium labeled *Diosma 4 ericoides* was received by Linnaeus sometime between 1755 and 1759. Nothing is known about who collected it or where it was collected. Fragments of the same collection found their way into several Swedish herbaria and were all labeled *Diosma ericoides* L. apparently because Linnaeus had decided that it agreed with his original concept of this species. *D. ericoides* L., Sp. Pl. Ed. 1 (1753) is now a synonym of *D. hirsuta*. The specimen of *D. recurva* seen by Chamisso, if it was housed in the Berlin herbarium, was most certainly destroyed during the 1934/45 war. Fortunately a portion, a small twig 14.5 mm long, is preserved in the herbarium of the Rijksmuseum at Stockholm. This has been chosen as the lectotype. It was collected in May 1819 by Mundt and Maire who gave the locality as "Cango" which is a rather vague area in the vicinity of Calitzdorp. Being without fruits, it closely resembles a specimen collected by Esterhuysen (25890) on the Touwsberg on 1st June 1956. The above description prepared from fresh material amplifies those previously given.

#### SPECIMENS EXAMINED

CAPE—3320 (Montagu): Touwsberg, dry rocky buttress of ridge on S. slopes, Ladismith Division (-DB), 3 000–3 500 ft., 1/6/1956, Esterhuysen 25890 (BOL, PRE, S); Warmwatersberg, State Forest W. of summit, S. Slopes, Swellendam Division

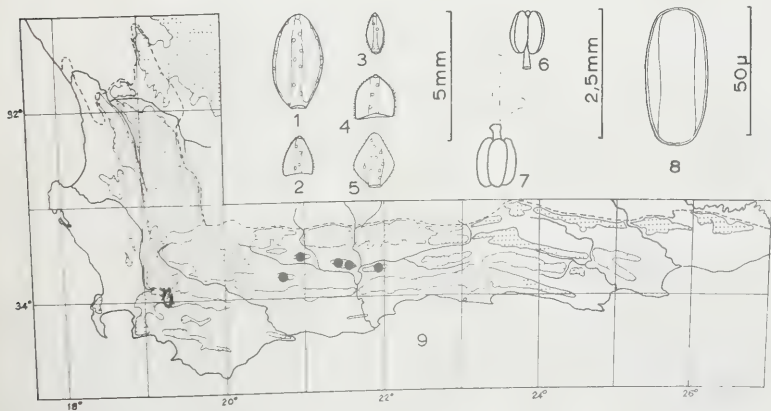


FIG. 20.

*Diosma recurva*: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, anther. 7, gynoeceium. 8, pollen. 9, distribution.

(-DC), 20/6/1971, *Kruger 1350* (JF); Warmwatersberg, S. Side near Barrydale, 3 600 ft., 4/12/1974, *Williams 1941* (NBG).

—3321 (Ladismith): Rooiberg, track to Mt. Ararat, Ladismith Division (-CB), c. 2 000 ft., 18/12/1977, *M. F. Thompson 3577* (STE); Roodeberg, S. Slopes, Ladismith Division (-DA), 24/5/1950, *Esterhuysen 17146* (BOL, PRE); Zoutkloof, Gamka Nature Reserve, Oudtshoorn Division (-DB), 2 200 ft., 11/10/1976, *Williams 2220* (NBG).

Without precise locality: Congo, -/5/1819, *Mundt & Maire s.n.* (S).

Without locality: *Diosma ericoides* L. (LD-ACHAR, LINN, S, UPS-THUNB).

#### DISTRIBUTION AND VARIATION

*Diosma recurva* is found only on the mountains of the Little Karoo, the Warmwatersberg, Touwsberg, Rooiberg and Gamtoosberg. These are all more or less isolated "islands" of Table Mountain Sandstone projecting above the plains composed of weathered Bokkeveld shales. Very few collections have been made although the plants, where they occur, are not rare.

The only apparent variation lies in the size of the mature fruit and seed; those from the eastern end of its range on the Gamtoosberg at Zoutkloof being the largest.

*Diosma recurva* is recognised as being a distinct species firstly because of its very strong sweetish smell and because of having leaves elliptic, obtuse, pale green, recurved and petals glabrous, gland-dotted.

**21. *Diosma prama*** Williams in J1 S.Afr. Bot. **41**. 4: 250 (1975). Type: CAPE—3321 (Ladismith): North side of Rooiberg Pass (-CC), 570 m, 12/7/1974, *Williams 1905* (NBG, holotype; BOL, C, K, M, MO, PRE, S, STE, isotypes).

*Diosma prama* is recognised as a distinct species because of its having branchlets virtually glabrous; leaves with pustulate gland dots scattered mainly towards the midrib; calyx lobes pustulate with gland dots but without any apical callus; petals glabrous, style erect and staminodes 0.2 mm long. It differs from *D. ramosissima* which has a closely spaced row of gland dots on either side of the midrib of the leaf, branches, leaves and petals puberulous and no staminodes. It differs also from *D. passerinoides* Steud. which has branchlets puberulous, leaves with one or two gland dots on the margins as well as on the midrib, calyx lobes without gland dots but with an apical callus and staminodes vestigial.

**22. *Diosma echinulata*** Williams in J1 S.Afr. Bot. **41**. 4: 265 (1975). Type: CAPE—3421 (Riversdale): Above Afvalskloof, Vermaaklikheid, Riversdale Division (-AC), 183 m (600 ft.) alt., 21/1/1975, *Williams 1953* (NBG, holotype; K, M, MO, PRE, S, STE, isotypes).

*Diosma echinulata* is recognised as distinct because of its having leaves alternate, closely spaced, setose, mucronate, thick and petiolate; petals

pubescent on the outside with a few hairs on the inside at the throat; ovary with the apices of the carpels setulose. It differs from *D. guthriei* which has leaves often opposite, glabrous, sessile with a blunt point and petals and ovary glabrous. It differs from *D. demissa* which is an entirely glabrous plant with obtuse leaves.

**23. *Diosma guthriei*** Glover in Ann. Bol. Herb. 1. 3: 126 (1915). Type: In Collibus prope Bredasdorp, 300 ft., -/7/1895, *H. Bolus* 8476 (BOL, lectotype; NBG, isotype). Rocky hill, Bredasdorp/Elim, 600 ft., 15/7/1895, *Guthrie* 3844 (BOL, cited as part of the type material).

Icon: Edwards in Ann. Bol. Herb. 1. 3. plate 15D (1915).

*Shrubs* 300–400 mm tall, spreading, rigid, arising from a very tough root-stock. *Branches* short, fairly stout, spreading or erect; bark greyish, rough. *Branchlets* fairly slender, short, erect, stiff, sometimes reddish, puberulous or glabrous, well clothed with leaves. *Leaves* 3–6,5 mm long, 2,5–3,7 mm broad, ovate, acute, opposite or alternate, spreading, sessile, glabrous; apex with a small blunt callus; margins thick, not translucent, spiky ciliate, sometimes almost eciliate, gland-dotted; adaxial surface concave; abaxial surface in two planes with a prominent midrib with scattered gland dots. *Inflorescence* terminal, 2 or 3-nate; *flowers* white, sessile, opening widely. *Bract* one to each flower, 2,9–3,6 mm long, 1,3–1,6 mm broad, oblong, glabrous; apex thickened with a small callus; margins gland-dotted, scabrid above, minutely ciliate below; midrib prominent. *Bracteoles* two, 2,1–2,9 mm long, 0,7–1 mm broad, oblong, obtuse, glabrous; apex thickened and three sided above with a small callus; margins minutely ciliate, translucent below; midrib gland-dotted. *Calyx lobes* five, 3 mm long, 1,2 mm broad, oblong, sub-obtuse, glabrous; apex callused; margins translucent and ciliate below. *Petals* five, 2,5 mm long, 2 mm broad, ovate, sub-obtuse, white, sessile and very much connate with the lobe of the disc; margins below sparsely ciliate. *Staminodes* five, a spherical gland about 0,2 mm diam., situated outside of the margin of the disc. *Filaments* five, becoming 1,7 mm long, glabrous, acicular, spreading. *Anthers* before anthesis 1,3 mm long, 0,7 mm broad, yellow; apical gland globose. *Pollen* 60  $\mu$  long, 28  $\mu$  diam., oblong. *Disc* 5-sinuate-crenulate, pale green with a dark green margin, exceeds the ovary by a long way, exudes nectar. *Stigma* 0,3 mm diam., globose, green, capitellate. *Style* becoming 1,8 mm long, terete, glabrous, deflexed at first. *Ovary* 5-carpellate, 1 mm diam., glabrous, apices globose and pale green. *Fruit* 5-carpellate, up to 12 mm long including the horns each up to 5 mm long, 6 mm diam., glabrous, gland-dotted; *horns* 4-carved. *Seed* 4–5 mm long overall, 1,8–2,1 mm broad, black, shining; aril blackish on one side, streaked on the other.

It would appear that the type material of this species was collected at the

same time by both Guthrie and Bolus in the limestone hills on the Elim side of Bredasdorp. The specimen depicted by G.E. Edwards accompanying the type description was that gathered by H. Bolus and has therefore been chosen as the lectotype. The above description prepared from fresh material amplifies that previously given.

#### SPECIMENS EXAMINED

CAPE—3149 (Caledon): near the vlei between Bredasdorp and Elim (-DB), 22/4/1932, *L. Bolus s.n.* (BOL 20529); Springfontein near the Salt Pan, Bredasdorp Division, 50 ft., 1/8/1973, *Williams 1832* (NBG, PRE, STE), 10/12/1948, *Matthews 36* (NBG); Mierkraal, Bredasdorp Poort, 100 ft., 22/1/1975, *Williams 1957* (NBG); Brandfontein, sand dunes along coast (-DD), 13/10/1951, *Esterhuysen 18972* (BOL, NBG, PRE).

—3419 (-DB)/—3420 (-DA) (Caledon/Bredasdorp): The Poort on the road from Bredasdorp to Elim, -/9/1933, *Leighton s.n.* (BOL 21515), *Compton 4371* (BOL), 5/8/1940, *Esterhuysen 3008* (BOL, GRA, NBG, PRE, SAM), 1/7/1947, *Compton 19566* (BOL, NBG), 4/8/1940, *Compton 9075* (NBG), 2/9/1943, *Barker 2497* (NBG, PRE), 24/1/1948, *Barker 269* (NBG), 300 ft., 11/11/1962, *Taylor 4311* (PRE, STE), -/1/1948, *Lewis 3095* (SAM), 100 ft., 11/11/1962, *Acocks 22990* (PRE).

—3420 (Bredasdorp): Rocky hill, Bredasdorp/Elim (-CA), 600 ft., 15/7/1895, *Guthrie 3844* (BOL); In collibus prope Bredasdorp, 300 ft., -/7/1895, *H. Bolus 8476* (BOL, NBG), 15/10/1951, *Esterhuysen 19137* (BOL, PRE); Kliprug (Frances Pratt), 15/10/1944, *Henrici 3708* (BOL); 5–6 miles from Struis Bay along road to Bredasdorp, 19/9/1962, *Esterhuysen 29711* (BOL); Sand dunes, Arniston, E. of Cape Agulhas, 24/9/1956, *Chamberlain 87* (BM); less than half a mile from Arniston towards Bredasdorp, 30–50 ft., 17/11/1971, *Williams 1599* (NBG); Bontebok Park, 16/4/1950, *Compton 21932* (NBG), 17/2/1951, *Compton 22626* (NBG); in calcareis planitie Zoutendalsvalley, Mierskalk (-CA/CC), -/12/1938, *Krauss s.n.* (G); Struis Bay in



FIG. 21.  
*Diosma guthriei*: distribution.

limestone (-CC), 5/8/1940, *Esterhuysen* 3025 (BOL, PRE), 50 ft., 21/6/1972, *Williams* 1658 (NBG, PRE); between Struisbaai and Cape Agulhas, Bredasdorp Division, 100 ft., 9/12/1971, *Williams* 1604 (NBG, PRE), 15/1/1931, *Galpin* 11276 (PRE); Cape Agulhas, limestone, 13/1/1956, *Rycroft* 1866 (BOL, NBG), 18/9/1962, *Esterhuysen* 29700 (BOL), 6/12/1938, *Wall* s.n. (S).

#### DISTRIBUTION

*Diosma guthriei* is found growing on or near tertiary limestone deposits in a fairly small area between Bredasdorp, Arniston and Cape Agulhas. It is one of four rather similar species occupying a similar habitat. To the east one finds *D. echinulata* and to the west *D. haelkraalsensis* and *D. demissa*. No significant variation has been observed.

*Diosma guthriei* is recognised as distinct being a plant that grows normally on limestone with a very stout root and low stiff habit; having leaves ovate, alternate or opposite, glabrous; apices with a small blunt point; margins minutely serrulate or very short spiky ciliate, quite thick and with gland dots; flowers 2 or 3-nate, petals glabrous, ovary glabrous. It differs from *D. echinulata* which has petals pubescent; from *D. haelkraalsensis* which has smaller recurved leaves with margins narrowly translucent and from *D. demissa* which has elliptic, obtuse leaves.

**24. *Diosma haelkraalsensis*** Williams in JI S. Afr. Bot. **45**: 2: 172 (1979). Type: CAPE—3419 (Caledon): 2 km E.N.E. of Groothagelkraal, Bredasdorp Division (-DA), 110–170 m (350–550 ft.) alt., 24/4/1978, *Williams* 2486 (NBG, holotype; K, MO, PRE, S, isotypes).

*Diosma haelkraalsensis* with its decumbent habit, very short branchlets, small somewhat recurved leaves and small white flowers is a distinct species. It differs from *D. demissa* which has leaves alternate, obtuse with a single row of gland dots along the midrib; from *D. guthriei* which has leaves ovate, often opposite, more erect and thicker with margins not translucent and from *D. echinulata* which has leaves alternate, lanceolate-elliptic, mucronate and sparsely setose on all sides.

**25. *Diosma demissa*** Williams in JI S. Afr. Bot. **41**: 4: 261 (1975). Type: CAPE—3419 (Caledon): Between Stanfords Cove and De Kelders, near the sea, Caledon Division (-CB), 15 m (50 ft.) alt., 20/7/1974, *Williams* 1909 (NBG, holotype; K, M, MO, PRE, S, STE, isotypes).

*Diosma demissa* is recognised as distinct having branches alternate and having leaves alternate, lanceolate, obtuse, petiolate, 5-ranked with a single row of gland dots on the midrib. It differs from *D. guthriei* which has branchlets often dichotomous, leaves much larger, ovate, acute, sessile, opposite or alternate with two rows of gland dots along the midrib.



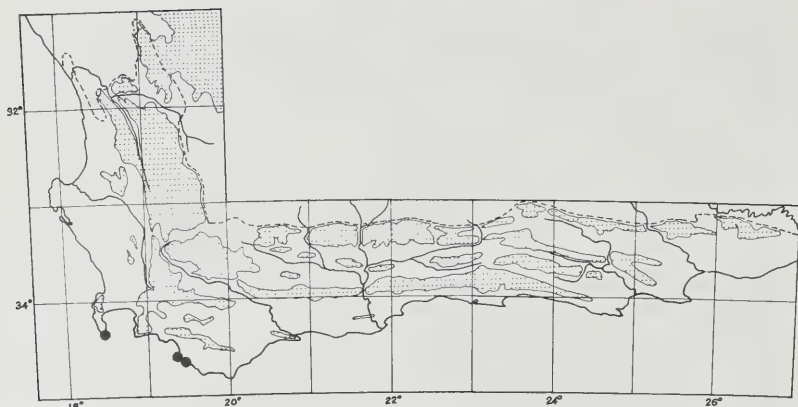


FIG. 22.  
*Diosma demissa*: distribution.

#### ADDITIONAL SPECIMEN EXAMINED

CAPE—3418 (Simonstown): Cape Point Reserve, crest of small plateau, wind swept area along path at end of road between parking area and Cape McClear, Cape Peninsula (-AD), 200 ft. alt., 2/8/1978, *Esterhuysen 34974* (BOL).

#### 26. *Diosma apetala* (Dümm.) Williams in Jl S. Afr. Bot. 40 4: 278 (1974).

*Acmadenia apetala* Dummer in Fedde Report. 11: 121 (1912). Type: South Africa, on moist and stony mountain places near Vrolykheid, 1 200–1 500 m, on the Great Zwartbergen, 3/8/1829, *Drège 2250* (K, holo.; G, P, isotypes).

*Diosma bolusii* Glover in Ann. Bol. Herb. 1. 3: 26 (1915). Type: Cape Province: South West Region; on rocky slopes of the Zwartberg Mountains in the Zwartberg Pass, Prince Albert Div., *H. Bolus 11460* (BOL, holo.; PRE. iso.).

Icon: Glover loc. cit. 1. 3. t. 15. f. c (1915).

*Shrubs* low, dense, spreading from a single stem at base; *branchlets* very short, erect-puberulous, densely foliate; *leaves* very small, lanceolate, triangular, sessile, appressed-erect, alternate with a row of gland dots along the midrib; *flowers* terminal, sessile, 1–2 nate, inconspicuous; petals five forming a cup which delapses as the flower opens; *disc* sinuate-crenulate, standing wide open, far exceeding the ovary.

#### SELECTED SPECIMENS EXAMINED

CAPE—3321 (Ladismith): Ladismith Div., West Klein Swartberg, Buffelsrivierpoort Mtns., 3 200 ft. (-AC), 26/4/1973, *Williams 1973* (NBG); Ladismith Div., S.

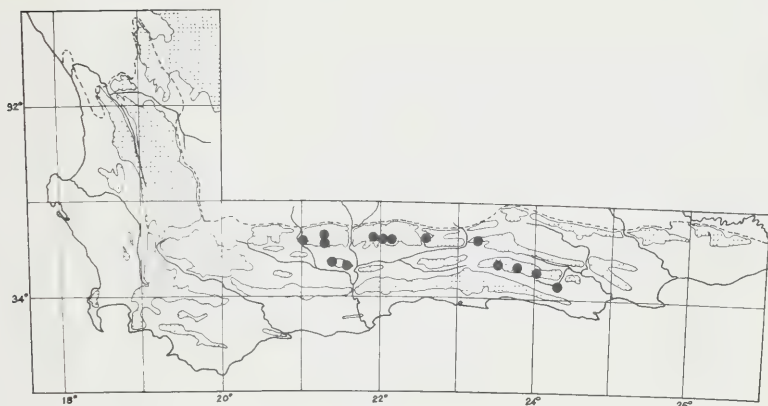


FIG. 23.  
*Diosma apetala*: distribution.

- Slopes of Swartberg below Toverkop, 3 500–4 000 ft. (-AC), 23/4/1951, *Esterhuysen* 18551 (BOL); Klein Swartberg, lower S. slopes near Ladismith, 3 000 ft. (-AD), -/12/1928, *Andreae* 1352 (BOL, PRE, STE); Laingsburg Div., N. slopes of Klein Swartberg, above Nietvoorby, 4 200 ft. (-AD), 25/4/1973, *Williams* 1788 (NBG, PRE, STE); Prince Albert Div., 8 miles W. from the top of Swartberg Pass, 5 000 ft. (-BD), 20/11/1954, *Stokoe* s.n. (SAM); Ladismith Div., Bailey Peak, Rooiberg, N. slopes, 4 500 ft. (-CB), 3/11/1975, *Williams* 2135 (NBG); Ladismith Div., stony S. slopes of Roodeberg (-DA), 20/5/1950, *Esterhuysen* 17174 (BOL, PRE).<sup>1</sup>
- 3322 (Oudtshoorn): Prince Albert Div., in praecipitibus saxosis montium Zwartbergen ad Zwartberg pass, 4 800 ft. (-AC), -/12/1904, *H. Bolus* 11460 (BOL, PRE); Oudtshoorn Div., Swartberg about 5 miles E. of pass (-AC), 29/1/1961, *Esterhuysen* 28816 (BOL); Oudtshoorn Div., slopes above Meirings poort, N. aspect (-BC), 16/10/1955, *Esterhuysen* 24844 (BOL); Prince Albert Div., Zwartbergen bui Vrolyk, 3 000–3 500 ft. (-BC), 3/8/1829, *Drège* 2250 (K, G, P).
- 3323 (Uniondale): Uniondale Div., Slopsteenberg S. slopes, 3 000–4 000 ft. (-AC/AD), 3/11/1941, *Esterhuysen* 6308 (BOL); Uniondale Div., Kouga Mtns., Saptokop summit, 5 595 ft. (-DA), 23/11/1958, *Esterhuysen* 27976 (BOL); Uniondale Div., Kouga Mtns., peak near Smutsberg, 4 000 ft. (-DB), 12/11/1944, *Esterhuysen* 10873 (BOL).
- 3324 (Steytlerville): Uniondale Div., Kouga Peak, rocky summit slopes, 4 500–5 600 ft. (-CA), 27/10/1949, *Esterhuysen* 16263 (BOL); Humansdorp Div., along road from Zuurans to Kouga (-CC), -/8/1942, *Fourcade* 5649 (BOL-FOURC).

#### DISTRIBUTION

*Diosma apetala* is found growing at altitudes of from 900–1 700 (3 000–5 600 ft.) above sea level in dry places on the Swartberg, Rooiberg and Kougaberg; a distance of about 300 km from west to east.

No significant variation has been observed.

*Diosma apetala* is recognised as distinct being the only species in which the petals, which form a cup over the flower in the bud stage, delapse before anthesis, their place then being taken by the pallid calyx lobes.

**27. *Diosma passerinoides* Steud.** in Flora 34: 549 (1830). Type: Ruckenhöhe circe 1 stande van Basson, 9/10/1826, von Ludwig s.n. (S, lectotype).

*Diosma obtusifolia* Sond. in Flor. Cap. 1: 377 (1860). Type: Drège 7114 (S).

*Shrubs* with several stems arising from a fairly stout rootstock, 300–400 mm tall, forming a dense bush with interlocking branches which may be associated with a tuft of grass. *Branches* short, variously bent, glabrous, leafless; *bark* dirty brown, fairly rough. *Branchlets* short, very numerous, fairly erect, slender, puberulous, well clothed but not hidden by the leaves. *Leaves* 2–3 mm long, 1–1,5 mm broad, elliptic, obtuse, sparsely scabrid-pubescent, sessile, erect, appressed at the base, spreading above, alternate, spirally 5-ranked; apex with a blunt callus; hyaline margins very narrow with very short spiky hairs; adaxial surface glabrous, flat when fresh; abaxial surface gland-dotted on both sides of the prominent midrib and on the margin. *Inflorescence* terminal, solitary, white. *Bract* leaf-like, 1,5 mm long, 0,8 mm broad, obtuse, minutely pubescent; margins narrow, ciliate below; apex calused. *Bracteoles* two, 1 mm long, 0,8 mm broad, sub-ovate, obtuse, calused, minutely and sparsely pubescent; apex thickened; margins minutely ciliate. *Calyx lobes* five, 1,7 mm long, 1,4 mm broad, somewhat deltoid, thickened with a blunt apical callus, spreading and somewhat recurved above, adaxially very short-pubescent, abaxially glabrous. *Petals* five, 3 mm long, 2,2 mm broad, ovate or sub-orbicular, obtuse, glabrous, white. *Staminal nodes* five, vestigial, a round swelling on the disc about 0,15 mm diam., or a translucent sessile sphere. *Filaments* five, becoming 1,8 mm long, acicular, glabrous. *Anthers* five, before anthesis 1,3 mm long, 0,8 mm broad, wine-coloured with a semi-immersed gland at the apex, adaxially somewhat yellow. *Pollen* 47  $\mu$  long, 23  $\mu$  broad, oblong. *Disc* 5-sinuate, 5-crenulate, green fleshy, well developed, standing wide open. *Stigma* 0,3 mm diam., green, capitellate. *Style* at first deflexed, becoming 1 mm long, glabrous. *Ovary* 5-carpellate, 1 mm diam., glabrous, becoming reddened, apices globose. *Fruit* 5-carpellate, 6 mm long, 5 mm diam., glabrous, pitted with gland dots to a varying degree; *horns* 1,5 mm long, spreading. *Seed* 4,5 mm long, 1,8 mm broad, black, shining; aril streaked with black.

Whilst on a botanical tour in 1826, Baron von Ludwig and his companion Ludwig Beil collected this species near the farm of Basson at Zoutrivier in what is now known as the Bredasdorp District. Von Ludwig's specimen seen by Steudel has not been traced. (The herbarium at Stuttgart was dispersed during the 1939/45 war.). Fortunately a fragment about 90 mm long is pre-

served in Sonder's herbarium at Stockholm and this has been chosen as the lectotype. A specimen, collected at the same time and place by Beil, is preserved in the herbarium of the South African Museum at Kirstenbosch. The area where this plant was originally found has now been brought under cultivation and it is doubtful if any plants still survive there.

On the same sheet with *D. passerinoides* in Sonder's herbarium is a specimen Drège 2250. This is *Diosma apetala* (Dümmer) Williams. It has leaves with a single row of gland dots along both sides of the midrib and along both margins. It is quite clear from Sonder's interpretation (Fl. Cap. 2: 377, 1860) of *D. passerinoides* that he regarded these two specimens to be conspecific. In fact Sonder's description appears to be based mainly upon the twig of *D. apetala*. One can understand that in describing his *D. obtusifolia* based upon Drège 7114, without locality, Sonder failed to notice that it was really conspecific with *D. passerinoides*.

The above description prepared from fresh material amplifies those previously given.

#### SPECIMENS EXAMINED

CAPE—3320 (Montagu): Potberg, west of Farm House, Bredasdorp Division (-BC), 500 ft. alt., 19/6/1979, Williams 2771 (NBG); Baden hillsides (-CA), 24/9/1946, Walgate s.n. (BOL), Lewis 1753 (SAM), Compton 18413 (NBG).

—3322 (Oudtshoorn): Eensameheid, Longkloof, George Division (-DD), 2 250/2 300 ft., 23/8/1975, Williams 2048A (NBG), 23/7/1973, Esterhuysen 33212 (BOL); lower clayish slopes of Kamanassie Mtns. at Laudina, Uniondale Division (-DB), 9/11/1949, Esterhuysen 16476 (BOL).

—3419 (Caledon): ad monte Swartberg (-AB), -/9/-, Zeyher s.n. (SAM); Onverwacht 19 miles W. of Riviersonderend (-BA), 900 ft., 29/8/1962, Acocks 22661 (PRE).

—3420 (Bredasdorp): Ruckenhöhe circa 1 stande van Basson (-AC), 9/10/1826, von Ludwig s.n. (S); in collibus apicis pone praedium Basson ad Zoutrivier -/10/-, Beil s.n. (SAM); Karsrivier van de Bruin bij Potberg, 9/8/1826, Beil s.n. (SAM); in collibus pr. Buffeljagsrivier, Swellendam Division (-BA), 800/1 200 ft., -/9/-, Zeyher ? s.n. (K); hills 1 km E. of Bredasdorp/Swellendam Road near Vrede (-AC/AD), 950 ft., 12/8/1973, Williams 1840 (NBG, PRE, S, STE); roundabout Jantjesbosch in the veld on the farm Nachtwacht, Bredasdorp Division (-CA), 150 ft., -/6/1927, Smith 4285 (PRE); on farm Nachtwacht near the school, Bredasdorp Division, -/9/1926, Smith 2970 (PRE).

—3421 (Riversdale): rocks on the Witteberg quartzite mass near Riversdale (-AB), 850 ft., 1/6/1924, Muir 3087 (BOL, PRE); Riversdale commonage, -/7/1909, Muir 409 (PRE); Oudetuin near Albertinia (-BA), -/5/1914, Muir s.n. (PRE).

Without locality: Drège 7114 (S).

#### DISTRIBUTION AND VARIATION

*Diosma passerinoides* is found growing in dry clayish soils in some way associated with patches of silcrete, on the coastal plain from near Greyton and Bredasdorp in the west to Albertinia in the east with outliers behind the

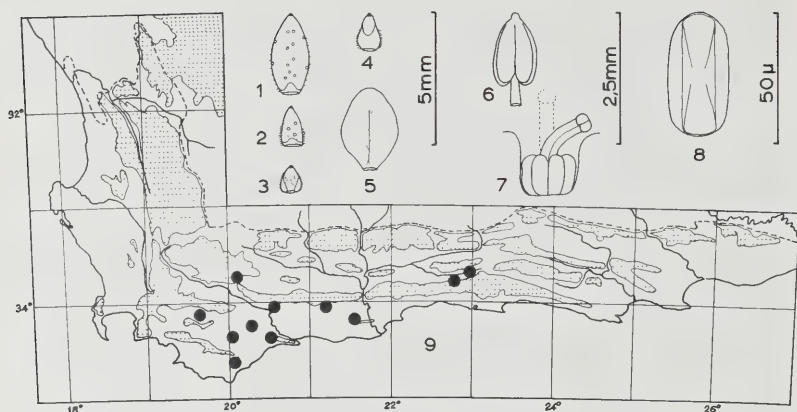


FIG. 24.

*Diosma passerinoides*: 1, leaf. 2, bract. 3, bracteole. 4, calyx lobe. 5, petal. 6, anther. 7, gynoecium. 8, pollen. 9, distribution.

mountains at Baden near Montagu and at Eensaamheid and Laudina near Uniondale. It is now extremely rare and very few plants are to be found.

The only variation that has been observed lies in the degree of pitting in the surface of the carpels of the mature fruits, those found near the Potberg being much more roughened than those found near Vrede on the Swellendam/Bredasdorp road.

*Diosma passerinoides* is recognised as distinct being a shrub up to 400 mm tall, branching from the base; with leaves elliptic, obtuse, minutely pubescent, sessile, erect, alternate with 4 rows of gland dots; with flowers solitary, terminal and with petals ovate, glabrous, narrowed to the base. It differs from *D. strumosa* which has the style and filaments sparsely and minutely pubescent.

**28. *Diosma strumosa*** Williams in Jl S. Afr. Bot. **45**:2: 180 (1979). Type: CAPE—3320 (Montagu): Southkloof, 11 km north of the main road near Barrydale, Swellendam Division (-DC), 760 m alt., 28/6/1977, Williams 2314 (NBG, holotype; BOL, K, L, M, MO, PRE, S, isotypes).

*Diosma strumosa* is recognised as distinct with its deeply pitted fruit, its long recurved petals, its wine-coloured anthers and disc and its style and filaments sparsely clothed with minute hairs.

#### PHYTOGEOGRAPHY

As can be seen from Figure 25 the main area of distribution of the fifteen



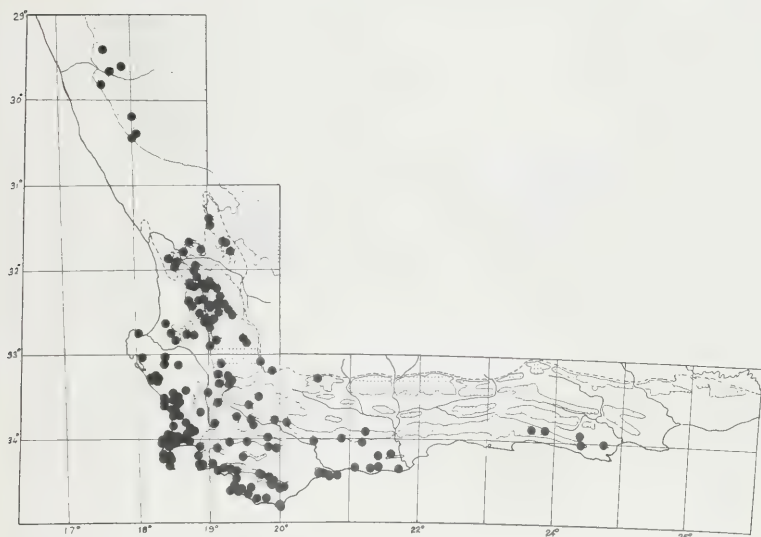


FIG. 25.  
Distribution of species in Section *Diosma*.

species in the section *Diosma* lies to the west of a line drawn through Cape Agulhas and Laingsburg. Only two species are found eastwards of this line: *D. sabulosa*, the distribution of which lies wholly eastwards and extends as far as Albertinia and *D. hirsuta*, a species ubiquitous in the S.W. Cape which also extends along the mountains as far eastwards as Humansdorp with a very large disjunction from Riversdale to Joubertina. Two species are unusual in that their areas of distribution extend beyond the limits of the Cape Geological Series into Little Namaqualand. For these two species to have migrated to or from Little Namaqualand, leaving a disjunction of as much as 250 km in the case of *D. ramosissima*, conditions of climate and perhaps soil must have been very different from those found today.

Seed in the *Diosmeae* is known to be transported by ants (W. Bond, written communication) and to be projected from the capsule a short distance when ripe but no method of long distance transportation of seed has ever been suggested in these genera. Of the species in the section *Diosma* seven occur in mountainous areas as well as at lower levels and several are found upon the coastal plain mostly fairly close to the sea.

Figure 26 shows the collection localities of all thirteen species in the section *Tumella*. As can be seen this forms an east-west pattern falling entirely

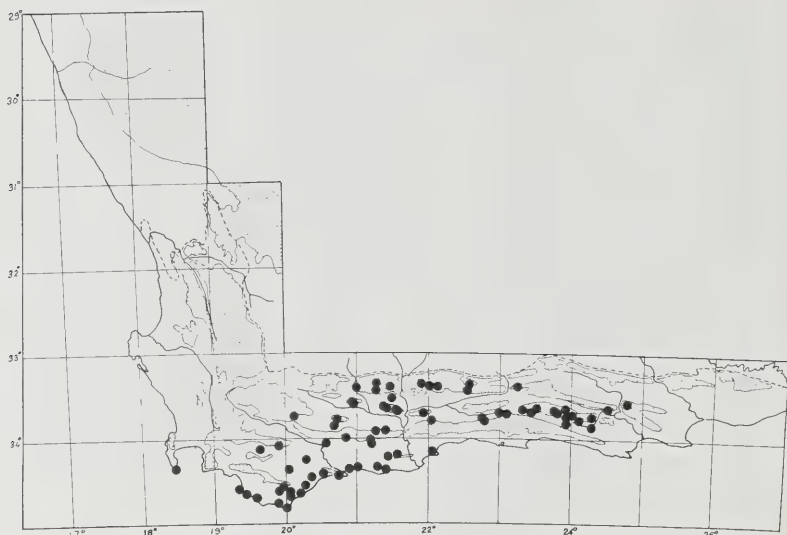


FIG. 26.  
Distribution of species in Section *Tumella*.

within the folded belt of the Cape Geological Series and terminating in the west approximately at a line drawn from Danger Point to Laingsburg. The difference in distribution between the two sections *Diosma* and *Tumella* is significant. A similar pattern was observed in the study of the genus *Leucadendron* (Williams, 1972) where the distribution of species was correlated with rainfall areas.

In the case of the genus *Diosma* species in the section *Diosma* are found almost entirely in the so-called *winter rainfall* zone and those in the section *Tumella* in the *non-seasonal rainfall* zone. In the section *Tumella* four species are found growing upon the limestone formations of the Bredasdorp beds. No species in the section *Diosma* occur upon limestone but four species are found growing in sandy ground nearby or associated with the limestone deposits in almost parallel situations. Going from west to east these species are in the section *Diosma*: *D. subulata*, *D. awilana*, *D. arenicola* and *D. sabulosa* and in the section *Tumella*: *D. demissa*, *D. haelkraalensis*, *D. guthriei* and *D. echinulata*.

Within the genus as a whole ten species may be said to be widespread or common, nine species fairly localised, eight species rather rare and one species may be extinct as it has only been collected once.

SPECIES IMPERFECTLY KNOWN

- (1). *Diosma cordata* Mart., Diss. Hort. Erlang.: 67 (1814).
- (2). *Diosma cordata* Wender. in Schrift. Ges. Bef. Gesammt. Naturw. Marb. 2: 248 (1831)—Hort.
- (3). *Diosma filiformis* Hort. ex Colla, Herb. Pedem. 1: 552 (1833).
- (4). *Diosma grandiflora* Burm. f., Flor. Cap. Prodr.: 6 (1768).
- (5). *Diosma lanceolata* Wender, in Schrift. Ges. Bef. Gesammt. Naturw. Marb. 2: 248 (1831)—Hort.
- (6). *Diosma plumosa* Colla., Herb. Pedem. 1: 552 (1833)—Type: A sterile fragment received from "Perret" (TO).

SPECIES EXCLUDED

1. *Diosma abietina* D. Dietr., Synops. Plant. 1: 829 (1839).  
*Euchaetis abietina* Eckl. & Zeyh., Enum. Plant.: 104 (1835).  
This is *Euchaetis glomerata* Bartl. & Wendl.
2. *Diosma acerosa* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 826 (1839).  
This is *Agathosma bisulca* Bartl. & Wendl.
3. *Diosma acuminata* DC. Prodr. 1: 715 (1824).  
*Bucco acuminata* Wendl. Collect. 1. t. 28 (1805).  
*Agathosma acuminata* Willd., Enum. Plant.: 260 (1809).  
This is *Agathosma imbricata* (L.) Willd.
4. *Diosma acuminata* Lodd., Bot. Cab. t. 493 (1821).  
*Adenandra acuminata* (Lodd.) Sweet, Hort. Brit. ed. 1: 88 (1826).  
This is *Adenandra villosa* (Berg.) Licht. ex Roem. & Schult.
5. *Diosma acuta* Lee, ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 182 (1824)—nom. nud.
6. *Diosma adenocaulis* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 826 (1839).  
This is *Agathosma hirta* Bartl. & Wendl.
7. *Diosma alba* Thunb., Prodr. Plant. Cap. 1: 84 (1794).  
This is *Coleonema album* (Thunb.) Bartl. & Wendl.
8. *Diosma alpina* D. Dietr., Synops. Plant. 1: 828 (1839).  
*Barosma alpina* Eckl. & Zeyh., Enum. Plant.: 102 (1835).  
This is *Agathosma odoratissima* (Mont.) Pillans
9. *Diosma ambigua* Lodd., Bot. Cab. t. 461 (1820).  
This is *Agathosma ciliata* Link
10. *Diosma amoena* Lodd., Bot. Cab. t. 161 (1818).  
This is *Adenandra villosa* (Berg.) Licht. ex. Roem. & Schult. ssp. *orbicularis* Strid.
11. *Diosma angustifolia* Hook. in Curt. Bot. Mag. sub. t. 3340 (1834)—nom. nud.  
This is *Coleonema pulchrum* Hook.
12. *Diosma apicuata* Spreng., Syst. Veg. 1: 787 (1825).  
This is *Agathosma apiculata* G. F. W. Mey. ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 176 (1824).
13. *Diosma asiatica* Lour. Fl. Cochinch. 1: 161 (=Pseudiosma ?)—Cochinchina.
14. *Diosma asperifolia* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 825 (1839).  
This is *Agathosma asperifolia* Eckl. & Zeyh.
15. *Diosma aulonophila* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 826 (1839).

This is *Agathosma virgata* Bartl. & Wendl.

16. *Diosma barbata* Berg. Herb. ex. Sond. in Flor. Cap. 1: 439 (1860)—nom. nud.

17. *Diosma barbata* (Spreng.) DC., Prodr. 1: 715 (1824).

*Agathosma barbatum* Spreng., Pugill. 1: 20 (1813).

Most certainly not *Diosma*.

18. *Diosma barbiger* Linn. f., Suppl. Plant.: 155 (1781).

This is *Macrostylis barbiger* (Linn. f.) Bartl. & Wendl.

19. *Diosma barosmaefolia* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 825 (1839).

This is *Agathosma bisulca* Bartl. & Wendl.

20. *Diosma berzeliaefolia* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 827 (1839).

This is *Agathosma virgata* Bartl. & Wendl.

21. *Diosma betulina* Lam. Encycl. Meth. Bot. 2: 288 (1786).

This is *Agathosma odoratissima* (Mont.) Pillans

22. *Diosma betulina* Thunb., Prodr. Plant.: 43 (1794).

*Hartogia betulina* Berg., Plant. Cap.: 67 (1767).

This is *Agathosma betulina* (Berg.) Pillans

23. *Diosma bifida* Jacq., Coll. 3: 278 (1789).

This is *Agathosma bifida* (Jacq.) Bartl. & Wendl.

24. *Diosma bifurca* (typographical error) Willd., Sp. Pl. 1: 1136 (1798).

This is *Agathosma bisulca* (Thunb.) Bartl. & Wendl.

25. *Diosma biophylla* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 825 (1839).

This is *Agathosma hirta* Bartl. & Wendl.

26. *Diosma biseriata* (Mey. ex Bartl. & Wendl.) Spreng., Syst. Veg. 1: 784 (1825).

*Adenandra biseriata* G. F. W. Meyer ex Bartl. & Wendl., Diosmeae in Beitr. Bot. 1: 75 (1824).

This is *Adenandra villosa* (Berg.) Licht. ex Roem. & Schult. ssp. *biseriata* (Mey. ex Bartl. & Wendl.) Strid.

27. *Diosma bisulca* Thunb., Prod. Plant, Cap.: 84 (1794).

This is *Agathosma bisulca* (Thunb.) Bartl. & Wendl.

28. *Diosma brachyphylla* (Schld.) D. Dietr., Synops. Plant. 1: 828 (1839).

This is *Adenandra brachyphylla* Schld.

29. *Diosma brevifolia* Lam., Encycl. Meth. Bot. 2: 285 (1786).

This is *Agathosma capensis* (L.) Dümmer

30. *Diosma bruniades* Link, Enum. Hort. Berol. 1: 237 (1821).

This is *Agathosma serpyllacea* (Licht. ex Roem. & Schult.) Bartl. & Wendl.

31. *Diosma calycina* Steud. in Flora 13: 549 (1830).

This is *Coleonema calycinum* (Steud.) Williams

32. *Diosma calycina* Tausch in Flora 13: 554 (1830).

This is *Adenandra villosa* ssp. *sonderi* (Dümmer) Strid.

33. *Diosma capensis* Ait. Hort. Kew. 3: 488 (1789).

*Hartogia capensis* L., Syst. Nat. ed. 10, 2: 939 (1759).

This is *Agathosma capensis* (L.) Dümmer

34. *Diosma capensis* L., Mant. 2: 343 (1771).

*Hartogia capensis* L., Sp. Pl. ed. 3, 1: 288 (1764).

This is some species of *Agathosma*.

35. *Diosma capita* L. Mant. 2: 210 (1771).

This is *Audouinia capitata* (L.) Brongn.

36. *Diosma capitata* Dumont de Cours, Bot. Cult. ed. 2. 5: 405 (1811).

This is *Agathosma ciliata* Link

37. *Diosma cerefolia* Vent., Jard. Malm.: 93 (1804).  
This is *Agathosma cerefolium* (Vent.) Bartl. & Wendl.
38. *Diosma chortophila* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 827 (1839).  
This is *Agathosma capensis* (L.) Dümmer
39. *Diosma ciliata* Lam., Encycl. Meth. Bot. 2: 287 (1786).  
This is *Agathosma ciliaris* (L.) Druce
40. *Diosma ciliata* L., Sp. pl. 1: 198 (1753).  
This is *Agathosma ciliata* Link
41. *Diosma ciliata* Thunb., Prodr. Plant. Cap.: 43 (1794).  
This is *Agathosma capensis* (L.) Dümmer
42. *Diosma cistoides* Lam., Encycl. Meth. Bot. 2: 289 (1786).  
This is a species of *Adenandra*.
43. *Diosma collina* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 825 (1839).  
This is *Agathosma collina* Eckl. & Zeyh.
44. *Diosma cordata* Mart., Enum. Hort. Erlang.: 67 (1814) = *Agathosma imbri-cata* ?
45. *Diosma coriacea* DC., Prodr. 1: 713 (1824).  
This is *Adenandra coriacea* Licht. ex Roem. & Schult.
46. *Diosma corymbosa* Montin, in Phys. Sallsk. Handl. 1: 106 (1776).  
This is *Agathosma corymbosa* (Mont.) G. Don, Gen. Syst. 1: 789 (1831).
47. *Diosma crenata* L., Syst. nat. ed. 10, 2: 940 (1759).  
This is *Agathosma crenulata* (L.) Pillans
48. *Diosma crenata* Lodd., Bot. Cab. 51. t. 404 (1820).  
This is *Agathosma betulina* (Berg.) Pillans
49. *Diosma crenulata* L., Cent. Plant. 2: 11 (1755).  
This is *Agathosma crenulata* (L.) Pillans
50. *Diosma cupressina* L., Mant.: 50 (1767).  
This is most probably *Thamnia uniflora* Soland ex Brongn.
51. *Diosma cuspidata* Thunb. in Hoffm. Phytogr. Blaett., 1: 24 (1803).  
This is *Linconia cuspidata* (Thunb.) Swartz
52. *Diosma cuspidata* Spreng. Syst. Veg. 1: 785 (1825).  
This is *Adenandra villosa* (Berg.) Licht. ex Roem. & Schult.
53. *Diosma cuspidata* (Bartl. & Wendl.) D. Dietr., Synops. Plant. 1: 826 (1839).  
This is *Agathosma serpyllacea* (Licht. ex Roem. & Schult.) Bartl. & Wendl.
54. *Diosma cymnoides* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 827 (1839).  
This is *Agathosma capensis* (L.) Dümmer
55. *Diosma decumbens* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 827 (1839).  
This is *Agathosma capensis* (L.) Dümmer
56. *Diosma deflexa* Desf. in Steud. Nom. Bot. 1: 512 (1841) = *Agathosma deflexa*, an unknown species.
57. *Diosma deusta* Thunb. in Hoffm. Phytogr. Blaett. 1: 25 (1803).  
This is *Linconia deusta* (Thunb.) Pillans
58. *Diosma dioica* Ker-Gawl. in Edwards' Bot. Reg. t. 502 (1820).  
This is *Agathosma ovata* (Thunb.) Pillans
59. *Diosma dubia* Spreng. ex Steud. in Flora 13: 548 (1830).  
This is *Agathosma puberula* (Steud.) Fourcade
60. *Diosma eckloniana* (Schldl.) D. Dietr., Synops. Plant. 1: 826 (1839).  
This is *Agathosma serpyllacea* (Licht. ex Roem. & Schult.) Bartl. & Wendl.
61. *Diosma elata* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 829 (1839).  
This is *Euchaetis elata* Eckl. & Zeyh.



62. *Diosma ensata* Thunb., Prod. Plant. Cap.: 43 (1794).  
This is *Empleurum unicapsulare* (L.f.) Skeels
63. *Diosma erecta* (Wendl.) DC. Prodr. 1: 715 (1824).  
This is *Agathosma capensis* (L.) Dümmer
64. *Diosma eriantha* Steud. in Flora 13: 550 (1830).  
This is *Agathosma eriantha* (Steud.) Steud.
65. *Diosma fastigiata* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 827 (1839).  
This is *Agathosma capensis* (L.) Dümmer
66. *Diosma ferulacea* Hort. Kew. ex Sond. in Flor. Cap. 1: 376 (1860)—nom. nud.  
This is *Acmadenia teretifolia* (Link) Phillips
67. *Diosma filipetala* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 826 (1839).  
This is *Agathosma stenopetala* (Steud.) Steud.
68. *Diosma flaccida* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 827 (1839).  
This is *Acmadenia flaccida* Eckl. & Zeyh.
69. *Diosma flexilis* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 829 (1839).  
This is *Euchaetis flexilis* Eckl. & Zeyh.
70. *Diosma foetidissima* (Bartl. & Wendl.) Spreng. Syst. Veg. 1: 785 (1825).  
This is *Agathosma foetidissima* Hortul. ex Steud.
71. *Diosma fragrans* Sims, Bot. Mag. t. 1519 (1813).  
This is *Adenandra fragrans* (Sims) Roem. & Schult.
72. *Diosma geminifolia* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 826 (1839).  
This is *Agathosma capensis* (L.) Dümmer
73. *Diosma glabra* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 827 (1839).  
This is *Agathosma serpyllacea* (Licht. ex Roem. & Schult.) Bartl. & Wendl.
74. *Diosma glandulosa* Hort. ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 110 (1824).  
This is *Agathosma ovata* (Thunb.) Pillans
75. *Diosma glandulosa* Thunb., Diss. Diosm.: 386 (1797).  
This is *Agathosma glandulosa* Sond.
76. *Diosma glauca* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 825 (1839).  
This is *Agathosma bisulca* Bartl. & Wendl.
77. *Diosma glomerata* G. F. W. Mey. ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 16 (1824)—nom. nud.  
This is *Euchaetis glomerata* Bartl. & Wendl.
78. *Diosma gnidioides* D. Dietr., Synops. Plant. 1: 829 (1839).  
*Agathosma gnidioides* Schldl. in Linnaea 6: 206 (1831).  
This is *Agathosma puberula* (Steud.) Fourcade
79. *Diosma gonaquensis* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 825 (1839).  
This is *Agathosma gonaquensis* Eckl. & Zeyh.
80. *Diosma gracilis* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 828 (1839).  
This is *Adenandra gracilis* Eckl. & Zeyh.
81. *Diosma graveolens* Licht. ex Roem. & Schult., Syst. Veg. 5: 461 (1819).  
This is *Agathosma ovata* (Thunb.) Pillans
82. *Diosma hirta* Lam., Encycl. Meth. Bot. 2: 286 (1786).  
This is *Agathosma hirta* (Lam.) Bartl. & Wendl.
83. *Diosma hirta* Vent., Jard. Malm. t. 72 (1803).  
This is *Agathosma corymbosa* (Mont.) G. Don
84. *Diosma hispida* Hort. Angl. ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 159 (1824)—nom. nud.  
This is *Agathosma cerefolium* (Vent.) Bartl. & Wendl.

85. *Diosma hispida* Hort. ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 183 (1824)—nom. nud.  
This is *Agathosma serpyllacea* (Licht. ex Roem. & Schult.) Bartl. & Wendl.
86. *Diosma hispida* Thunb., Prodr.: 42 (1794).  
This is *Agathosma hispida* (Thunb.) Bartl. & Wendl.
87. *Diosma humilis* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 828 (1839).  
*Adenandra humilis* Eckl. & Zeyh., Enum. Plant.: 99 (1836).  
This is *Adenandra marginata* (L.f.) Roem. & Schult.
88. *Diosma hybrida* Hort. Angl. ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 167 (1824)—nom. nud.  
*Agathosma hybrida* Bartl. & Wendl. loc. cit.  
This is *Agathosma ciliaris* (L.) Druce
89. *Diosma hybrida* Spreng. Syst. Veg. 1: 787 (1825).  
This is a species of *Agathosma*
90. *Diosma hyponeura* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 826 (1839).  
This is *Agathosma serpyllacea* (Licht. ex Roem. & Schult.) Bartl. & Wendl.
91. *Diosma imbricata* L. Syst. Veg. ed. 14.: 239 (1784).  
This is *Agathosma imbricata* (L.) Willd.
92. *Diosma imbricatum* Dumont de Cours. Bot. Cult. ed. 2. 5: 405 (1811).  
This is *Audouinia capitata* Brongn.
93. *Diosma intermedia* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 828 (1839).  
*Adenandra intermedia* Eckl. & Zeyh., Enum. Plant.: 99 (1835).  
This is *Adenandra marginata* (L.f.) Roem. & Schult.
94. *Diosma involucrata* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 825 (1839).  
This is *Agathosma involucrata* Eckl. & Zeyh.
95. *Diosma joubertiana* (Schldl.) D. Dietr., Synops. Plant. 1: 825 (1839).  
This is *Agathosma joubertiana* Schldl.
96. *Diosma juniperina* (Bartl. & Wendl.) Spreng. Syst. Veg. 1: 784 (1825).  
*Acmadenia juniperina* Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 61 (1824).  
This is *Acmadenia obtusata* (Thunb.) Bartl. & Wendl.
97. *Diosma juniperina* Moench, Meth. Plant. Hort. Marb.—Suppl.: 26 (1802).  
This is *Coleonema album* (Thunb.) Bartl. & Wendl.
98. *Diosma laevigata* (Bartl. & Wendl.) Spreng., Syst. Veg. 1: 784 (1825).  
*Acmadenia laevigata* Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 64 (1824).  
This is *Euchaetis meridionalis* Williams
99. *Diosma lanceolata* Ker-Gawl. in Edwards', Bot. Reg. t. 476 (1820).  
This is *Agathosma ciliaris* (L.) Druce
100. *Diosma lanceolata* L., Mant. Alt.: 343 (1771).  
This is *Agathosma lanceolata* (L.) Engl.
101. *Diosma lanceolata* Thunb., Prodr. Plant. Cap.: 43 (1794).  
This is *Agathosma ovata* (Thunb.) Pillans
102. *Diosma lancifolia* Schmidt, Neue u. Selt. Pfl.: 37 (1793).  
This is *Agathosma capensis* (L.) Dümmer
103. *Diosma lasiophylla* Spreng., Syst. Veg. 1: 787 (1825).  
This is *Agathosma corymbosa* (Mont.) G. Don
104. *Diosma latifolia* Andr., Bot. Rep. t. 33 (1797).  
This is *Agathosma crenulata* (L.) Pillans
105. *Diosma latifolia* L. f., Suppl.: 154 (1781).  
This is *Agathosma odoratissima* (Mont.) Pillans
106. *Diosma laxa* Spreng., Syst. Veg. 1: 787 (1825).  
This is *Agathosma corymbosa* (Mont.) G. Don

107. *Diosma lediformis* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 824 (1839).  
 This is *Agathosma bifida* (Jacq.) Bartl. & Wendl.
108. *Diosma leiophylla* Spreng., Syst. Veg. 1: 787 (1825).  
 This is *Agathosma glabrata* Bartl. & Wendl.
109. *Diosma lichtensteiniana* D. Dietr., Synops. Plant. 1: 828 (1839).  
 This is *Adenandra villosa* (Berg.) Licht. ex Roem. & Schult.
110. *Diosma linearis* Thunb., Prod. Plant. Cap.: 43 (1794).  
 This is *Adenandra uniflora* (L.) Willd.
111. *Diosma linifolia* DC., Prodr. 1: 715 (1824).  
 This is *Agathosma linifolia* Licht. ex Bartl. & Wendl.
112. *Diosma linifolia* Lodd. Bot. Cab. 4. t. 400 (1819).  
 This is *Agathosma ovata* (Thunb.) Pillans
113. *Diosma lycopodioides* Willd. ex Roem. & Schult., Syst. Veg. 5: 461 (1819).  
 This is *Agathosma imbricata* (L.) Willd.
114. *Diosma marginata* L. f., Suppl.: 155 (1781).  
 This is *Agathosma marginata* (L.f.) Roem. & Schult.
115. *Diosma marifolia* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 826 (1839).  
 This is *Agathosma marifolia* Eckl. & Zeyh.
116. *Diosma marlothii* Dümmer in Ann. Bol. Herb. 3: 1 (1920).  
 This is *Acmadenia matroosbergensis* Phillips
117. *Diosma meyeri* D. Dietr. Synops. Plant. 1: 828 (1839).  
 This is *Adenandra villosa* (Berg.) Licht. ex Roem. & Schult.
118. *Diosma micropylla* (Bartl. & Wendl.) Spreng., Syst. Veg. 1: 787 (1825).  
*Agathosma microphylla* G. F. W. Mey. ex Bartl. & Wendl. Diosm. in Beitr. Bot. 1: 173 (1824).  
 This is *Agathosma cerefolium* (Vent.) Bartl. & Wendl.
119. *Diosma mixta* Hort. Kew. ex Bartl. & Wendl. Diosm. in Beitr. Bot. 1: 182 (1824)—nom. nud.
- This is *Agathosma serpyllacea* (Licht. ex Roem. & Schult.) Bartl. & Wendl.
120. *Diosma mollis* (Bartl. & Wendl.) D. Dietr., Synops. Plant. 1: 825 (1839).  
 This is *Agathosma ciliaris* (L.) Druce
121. *Diosma montana* (Schldt.) D. Dietr., Synops. Plant. 1: 825 (1839).  
 This is *Agathosma bifida* (Jacq.) Bartl. & Wendl.
122. *Diosma mundiaefolia* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 828 (1839).  
 This is *Adenandra mundiifolia* Eckl. & Zeyh.
123. *Diosma mundiana* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 827 (1839).
- This is *Acmadenia mundiana* Eckl. & Zeyh.
124. *Diosma muraltioides* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 828 (1839).  
 This is *Acmadenia obtusata* (Thunb.) Bartl. & Wendl.
125. *Diosma myrsinites* Lam., Tabl. Encycl. Meth. Bot. 2: 82 (1823).  
 This is *Agathosma ciliata* (L.) Link
126. *Diosma myrtifolia* Hort. Angl. ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 156 (1824)—nom. nud.
- This is *Agathosma ciliata* (L.) Link
127. *Diosma nigra* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 827 (1839).  
 This is *Agathosma capensis* (L.) Dümmer

128. *Diosma nigromontana* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 825 (1839).  
 This is *Agathosma bifida* (Jacq.) Bartl. & Wendl.
129. *Diosma nodosa* (Thunb.) D. Dietr. Synops. Plant. 1: 827 (1839).  
 This is *Agathosma virgata* Bartl. & Wendl. fide Steud. Nom. Bot.: 512 (1841).
130. *Diosma oblonga* Thunb. in Hoffm. Phytogr. Blaetter, 1: 23 (1803).  
 This is *Agathosma ovata* (Thunb.) Pillans
131. *Diosma obtusa* (Wendl.) DC., Prodr. 1: 714 (1824).  
*Bucco obtusa* Wendl. Coll. 1: 45 (1805).
- This is *Agathosma ciliaris* (L.) Druce
132. *Diosma obtusa* G. F. W. Mey. in Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 197 (1824)—nom. nud.
- This is *Macrostylis squarrosa* Bartl. & Wendl.
133. *Diosma obtusata* Thunb., Prodr. Plant. Cap.: 84 (1794).  
 This is *Acmadenia obtusata* (Thunb.) Bartl. & Wendl.
134. *Diosma odorata* (Wendl.) DC., Prodr. 1: 714 (1824).  
*Parapetalifera odorata* Wendl., Coll. 1: 50, t. 15 (1805).
- This is *Agathosma crenulata* (L.) Pillans
135. *Diosma odoratissima* Montin, in Phys. Sallsk. Handl. 1: 104 (1776).  
 This is *Agathosma odoratissima* (Mont.) Pillans
136. *Diosma orbicularis* Hortul. ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 110 (1824)—nom. nud.
- This is *Agathosma ovata* (Thunb.) Pillans
137. *Diosma orbicularis* Thunb., Prodr. Plant. Cap.: 84 (1794).  
 This is *Agathosma orbicularis* (Thunb.) Bartl. & Wendl.
138. *Diosma ovata* Thunb., Prodr. Plant. Cap.: 43 (1794)—p.p. There are two species here in Herb. Thunberg.  
 a. *Agathosma ovata* (Thunb.) Pillans  
 b. *Adenandra villosa* (Berg.) Licht. ex Roem. & Schult. ssp. *sonderi* (Dümmer) Strid
139. *Diosma ovata* Lodd. Cat. Plant.: 14 (1818) in Lodd. Bot. Cab. 2 (1818)—nom. nud.?
140. *Diosma parviflora* Willd. ex Roem. & Schult., Syst. Veg. 5: 462 (1819).  
 This is *Agathosma virgata* (Lam.) Bartl. & Wendl.
141. *Diosma patentissima* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 826 (1839).  
 This is *Agathosma virgata* (Lam.) Bartl. & Wendl.
142. *Diosma patula* Spreng., Syst. Veg. 1: 786 (1825).  
*Agathosma patula* G. F. W. Mey. ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 134 (1824).
- This is *Agathosma capensis* (L.) Dümmer
143. *Diosma pauciflora* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 829 (1839).  
*Barosma pauciflora* Eckl. & Zeyh., Enum. Plant.: 103 (1835).
- This is *Agathosma ovata* (Thunb.) Pillans
144. *Diosma perforata* Lam., Tabl. Encycl. Meth. Bot. 2: 82 (1797).  
*Agathosma perforata* (Lam.) G. Don, Gard. & Bot. 1: 789 (1831)
- This is a species of *Agathosma*.
145. *Diosma pilifera* Steud. in Flora 13: 549 (1830).  
 This is *Agathosma pilifera* (Steud.) Schidl. in Linnaea 6: 206 (1830).
146. *Diosma platypetala* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 827 (1839).  
 This is *Agathosma capensis* (L.) Dümmer

147. *Diosma prolifera* (Wendl.) DC., Prodr. 1: 718 (1824).  
*Bucco prolifera* Wendl. Collect. 3: 9, t. 77 (1811).  
 This is *Agathosma prolifera* (Wendl.) Bartl. & Wendl., a species imperfectly known.
148. *Diosma puberula* Steud. in Flora 13: 548 (1830).  
 This is *Agathosma puberula* (Steud.) Fourcade
149. *Diosma pubescens* Thunb., Prodr.: 43 (1794).  
 This is *Agathosma corymbosa* (Mont.) G. Don
150. *Diosma pulchella* Houtt., Nat. Hist. 2. 4: 328 (1775).  
 This is *Agathosma ovata* (Thunb.) Pillans
151. *Diosma pulchella* L., Sp. pl. 2: 288 (1762).  
 This is *Agathosma pulchella* (L.) Link
152. *Diosma punctata* Licht. ex Roem. & Schult., Syst. Veg. 5: 461 (1819).  
 This is *Agathosma ovata* (Thunb.) Pillans
153. *Diosma pungens* (Bartl. & Wendl.) Spreng., Syst. Veg. 1: 784 (1825).  
 This is *Euchaetis pungens* (Bartl. & Wendl.) Williams
154. *Diosma purpurea* Desf., Tabl. 2: 180 (1815).  
 This is *Agathosma corymbosa* (Mont.) G. Don
155. *Diosma purpurea* Hort. ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 163 (1824).  
 This is *Agathosma corymbosa* (Mont.) G. Don
156. *Diosma reflexa* Lodd. ex DC., Prodr. 1: 716 (1819).  
*Diosma reflexa* Lodd, Cat. Plant.: 14 (1818) in Lodd. Bot. Cab. 2 (1818)—nom. nud.  
 This is *Agathosma reflexa* Link, a species imperfectly known.
157. *Diosma reflexa* Soland. ex Sond. in Flor. Cap. 1: 419 (1860).  
 This is *Agathosma imbricata* (L.) Willd.
158. *Diosma robusta* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 825 (1839).  
 This is *Agathosma robusta* Eckl. & Zeyh.
159. *Diosma rosmarinifolia* Lam., Encycl. Meth. Bot. 2: 286 (1786).  
 This is *Adenandra marginata* (L.f.) Roem. & Schult. fide Sonder
160. *Diosma rotundifolia* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 828 (1839).  
 This is *Adenandra rotundifolia* Eckl. & Zeyh.
161. *Diosma rubra* L., Sp. pl. 1: 198 (1753) ex parte  
 There are two species on the sheets at LINN—*Diosma hirsuta* L. and *Coleonema album* (Thunb.) Bartl. & Wendl.
162. *Diosma rubra* L. sensu Berg., Plant. Cap.: 62 (1767).  
 This is *Coleonema album* (Thunb.) Bartl. & Wendl.
163. *Diosma rubra* Hort. ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 163 (1824)—nom. nud.  
 This is *Agathosma villosa* Willd.
164. *Diosma rufescens* Spreng., Syst. Veg. 1: 787 (1825).  
 This is *Agathosma refescens* (Spreng.) D. Don, an imperfectly known species.
165. *Diosma rugosa* Donn, Hort. Cantabr. ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 81 (1824) nom. nud.  
 This is *Adenandra villosa* (Berg.) Licht. ex Roem. & Schult.
166. *Diosma rugosa* Hort. Angl. ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 62 (1824)—nom. nud.  
 This is *Agathosma corymbosa* (Mont.) G. Don
167. *Diosma rugosa* Thunb., Prodr. Plant. Cap.: 43 (1794).  
 This is *Agathosma ciliaris* (L.) Druce



168. *Diosma schlechtendaliana* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 825 (1839).  
 This is *Agathosma eriantha* (Steud.) Steud.  
 169. *Diosma schmidtiana* Tausch. in Flora 13: 553 (1830).  
 This is *Adenandra villosa* (Berg.) Licht. ex Roem. & Schult.  
 170. *Diosma scoparia* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 829 (1839).  
*Barosma scoparia* Eckl. & Zeyh., Enum. Plant.: 103 (1835).  
 This is *Agathosma ovata* (Thunb.) Pillans  
 171. *Diosma sedifolia* (Schlechtendal) D. Dietr., Synops. Plant. 1: 825 (1839).  
 This is *Agathosma sedifolia* Schlechtendal  
 172. *Diosma serpyllacea* (Licht. ex Roem. & Schult.) DC., Prodr. 1: 715 (1824).  
*Bucco serpyllacea* Licht. ex Roem. & Schult., Syst. Veg. 5: 447 (1819).  
 This is *Agathosma serpyllacea* (Licht. ex Roem. & Schult.) Bartl. & Wendl.  
 173. *Diosma serrata* Blanco, Flor. Filip. 1: 168 (1873).  
 This is *Celastrus paniculatus* Willd.  
 174. *Diosma serratifolia* Curt., Bot. Mag.: 456 (1799).  
 This is *Agathosma serratifolia* (Curt.) Spreeth  
 175. *Diosma serruriaefolia* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 825 (1839).  
 This is *Agathosma bifida* (Jacq.) Bartl. & Wendl.  
 176. *Diosma spartiifolia* Steud. in Flora 13: 550 (1830).  
 This is *Agathosma ovata* (Thunb.) Pillans  
 177. *Diosma speciosa* Sims, Bot. Mag. t. 1271 (1810).  
 This is *Adenandra villosa* (Berg.) Licht. ex Roem. & Schult.  
 178. *Diosma speciosa* Hort. Cels. in Steud. Nom. Bot. 1: 513 (1841).  
 This is *Agathosma corymbosa* (Mont.) G. Don  
 179. *Diosma sphaerocephala* Lodd. Bot. Cab. 15: 1490 (1828).  
 This is *Agathosma foetidissima* Hortul. ex Steud.  
 180. *Diosma spicata* (Licht. ex Roem. & Schult.) DC., Prodr. 1: 715 (1824).  
*Bucco spicata* Licht. ex Roem. & Schult., Syst. Veg. 5: 448 (1819).  
 This is *Agathosma spicata* (Licht.) G. Don, an imperfectly known species.  
 181. *Diosma squalida* E. Mey. in Drège, Zwei. Pfl. Doc.: 179 (1844)—nom. nud.  
 This is *Raspalia globosa* (Lam.) Pillans  
 182. *Diosma squamosa* Willd. ex Roem. & Schult., Syst. Veg. 5: 462 (1819).  
 This is *Agathosma squamosa* (Willd. ex Roem. & Schult.) Bartl. & Wendl.  
 183. *Diosma squarrosa* Wendl. ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 198 (1824).  
 This is *Macrostylis squarrosa* Bartl. & Wendl.  
 184. *Diosma stadensis* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 826 (1839).  
 This is *Agathosma cerefolium* (Vent.) Bartl. & Wendl.  
 185. *Diosma stenopetala* Steud. in Flora 13: 549 (1830).  
 This is *Agathosma stenopetala* (Steud.) Steud.  
 186. *Diosma stenophylla* Spreng., Syst. Veg. 1: 785 (1825).  
 This is *Agathosma ovata* (Thunb.) Pillans  
 187. *Diosma stricta* Willd. ex Roem. & Schult., Syst. Veg. 5: 462 (1819).  
 This is *Agathosma serpyllacea* (Licht. ex Roem. & Schult.) Bartl. & Wendl.  
 188. *Diosma suaveolens* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 826 (1839).  
 This is *Agathosma cerefolium* (Vent.) Bartl. & Wendl.  
 189. *Diosma tenella* Lodd. Cat. in Bot. Cab. 2: 14 (1818)—nom. nud.  
 190. *Diosma tenuifolia* Presl. Bot. Bemerk.: 31 (1844)—nom. nud.  
 This is *Coleonema calycinum* (Steud.) Williams

191. *Diosma tenuissima* Willd., Enum. Plant. Hort. Berol. Suppl.: 12 (1813)—  
nom. nud.  
This is *Agathosma capensis* (L.) Dümmer
192. *Diosma teretifolia* Hort. Angl. ex Link, Enum. Hort. Berol. 1: 237 (1821).  
This is *Acmadenia teretifolia* (Link) Phillips
193. *Diosma ternata* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 829 (1839).  
*Barosma ternata* Eckl. & Zeyh., Enum. Plant.: 103 (1835).  
This is *Agathosma ovata* (Thunb.) Pillans
194. *Diosma tetragona*, L.f., Suppl. Plant.: 155 (1781).  
This is *Acmadenia tetragona* (L.f.) Bartl. & Wendl.
195. *Diosma thunbergiana* Spreng., Syst. Veg. 1: 786 (1825).  
This is *Agathosma capensis* (L.) Dümmer
196. *Diosma thymifolia* Willd. ex Roem. & Schult., Syst. Veg. 5: 462 (1819).  
This is *Agathosma ciliaris* (L.) Druce
197. *Diosma thyoides* Willd. ex Roem. & Schult., Syst. Veg. 5: 462 (1819).  
This is *Agathosma capensis* (L.) Dümmer
198. *Diosma tomentosa* Lee ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 168  
(1824)—nom. nud.  
This is *Agathosma ciliaris* (L.) Druce
199. *Diosma trachyphylla* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 825  
(1839).  
This is *Agathosma hispida* (Thunb.) Bartl. & Wendl
200. *Diosma uiteenhagensis* D. Dietr., Synops. Plant. 1: 827 (1839).  
This is *Agathosma capensis* (L.) Dümmer
201. *Diosma ulicina* Lodd. Cat. (1824)—nom. nud.  
This is apparently *Acmadenia obtusata* (Thunb.) Bartl. & Wendl.
202. *Diosma umbellata* Hort. ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 81  
(1824).  
This is *Adenandra villosa* (Berg.) Licht. ex Roem. & Schult.
203. *Diosma umbellata* Thunb. in Hoffm. Phytogr. Blaetter. 1: 24 (1803)  
This is *Agathosma bifida* (Jacq.) Bartl. & Wendl.
204. *Diosma undulata* Thunb., Flor. Cap. 2: 132 (1818) fide Ind. Kew.  
This appears to be a typographical error = *D. ustulata*.
205. *Diosma unicapsularis* L. f., Suppl. Plant.: 155 (1781).  
This is *Empleurum unicapsulare* (L.f) Skeels
206. *Diosma uniflora* Druce in Rep. Bot. Exch. Cl. Brit. Isles 1913.3: 417  
(1914)—nom. illegit.  
*Brunia uniflora* L. Sp. pl. 1: 199 (1753).  
*Diosma cupressina* L. Mant.: 50 (1767).  
This is possibly *Thamnia uniflora* Soland. ex Brongn.
207. *Diosma uniflora* L. Sp. pl.: 198 (1753).  
This is *Adenandra uniflora* (L.) Willd., on the same sheet in LINN are specimens  
of *A. villosa*.
208. *Diosma ustulata* Thunb. in Hoffm. Phytogr. Blaetter. 1: 25 (1803).  
This most probably is *Thamnea uniflora* Soland. ex Brongn.
209. *Diosma ventenatiana* (Roem. & Schult.) Spreng., Syst. Veg. 1: 786 (1825).  
*Bucco ventenatiana* Roem. & Schult. 5: 442 (1819).  
This is *Agathosma corymbosa* (Mont.) G. Don
210. *Diosma venusta* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 829 (1839).  
*Barosma venusta* Eckl. & Zeyh., Enum. Plant.: 102 (1835).  
This is *Agathosma venusta* (Eckl. & Zeyh.) Pillans

211. *Diosma vestita* (Licht. ex Roem. & Schult.) DC., Prodr. 1: 715 (1824).  
*Bucco vestita* Licht. ex Roem. & Schult., Syst. Veg. 5: 447 (1819).  
 This is *Agathosma imbricata* (L.) Willd.  
 212. *Diosma villosa* Thunb., Prodr. Plant Cap.: 43 (1749).  
 This is *Macrostylis villosa* (Thunb.) Sonder  
 213. *Diosma virgata* Hort. ex Bartl. & Wendl., Diosm. in Beitr. Bot. 1: 145 (1824)—nom. nud.  
 This is *Agathosma imbricata* (L.) Willd.  
 214. *Diosma virgata* Lam., Encycl. Meth. Bot. 2: 286 (1876).  
 This is *Agathosma virgata* (Lam.) Bartl. & Wendl.  
 215. *Diosma virgata* G. F. W. Mey. (not E. Mey.) ex Sond. in Flor. Cap. 1: 378 (1869).  
 This is *Coleonema juniperinum* Sonder in Drège's collections.  
 216. *Diosma viscida* (Eckl. & Zeyh.) D. Dietr., Synops. Plant. 1: 828 (1839).  
 This is *Adenandra viscida* Eckl. & Zeyh.  
 217. *Diosma wendlandiana* DC., Prodr. 1: 715 (1824).  
 This is *Agathosma corymbosa* (Mont.) G. Don  
 218. *Diosma wittebergensis* Compton in Trans. Roy. Soc. S. Afr. 19: 297 (1931).  
 This is *Acmadenia wittebergensis* (Compton) Williams

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## CHROMOSOME STUDIES IN THE SOUTHERN AFRICAN FLORA: 30-37

C. G. VOSA

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### 30. *ALOE RUPESTRIS* Bak.

CHROMOSOME NUMBER:  $2n = 14$  (Figs 1a, b).

ORIGIN OF MATERIAL: Hills near Greytown, Zululand, C. G. Vosa 2362.

METHOD OF PREPARATION: Root-tip material, colchicine pretreatment. Feulgen (acetic-orcein) staining.

OBSERVATIONS: This species, and the seven others in this contribution, have been collected in the wild by the author as young seedlings. Together with voucher material raised from seeds, these are kept as living material at the Botany School and at the Botanic Garden, Oxford.

In all the species the karyotype is strictly bimodal with eight large (L) and six small (S) chromosomes.

Secondary constrictions and allocyclic regions of paler staining occur in intercalary and distal positions in most short arms of the L- and in the long arm of the S-chromosomes. Relatively thin secondary constrictions are sometimes found also in the long arm of the L-chromosomes.

The nucleolar attachments are generally distally located in the long arm of the L-chromosomes in the form of small satellites, and are usually found in heterozygous conditions in one, two or sometimes three chromosome pairs.

The morphology of the chromosome complement in *Aloe* is very similar to that found in *Haworthia* (Brandham, 1971; Vosa and Bayer, 1981).

The only detectable differences, relative only to the species so far investigated, are: 1) in most species of *Aloe* the S-chromosomes are slightly larger and 2) the chromosome complement of *Aloe*, overall, has less allocyclic segments than *Haworthia*.

In the line illustrations the haploid karyotypes have been prepared with measurements taken by camera lucida in three to five seedlings for each species. The nucleolar attachments are indicated by circles. In the micrographs the bar represents  $10\mu$ .



FIG. 1A

Mitotic metaphase in *Aloe rupestris* Bak. Note the secondary constrictions in the long arms of the second L-chromosome pair (arrows).

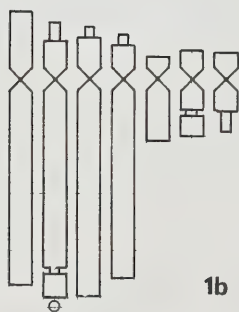


FIG. 1B

Diagrammatic representation of the haploid karyotype of *Aloe rupestris* Bak.



**31. ALOE GRANDIDENTATA** Salm Dyck

CHROMOSOME NUMBER:  $2n = 14$  (Figs 2a, b).

ORIGIN OF MATERIAL: Fauresmith Veld Reserve, O.F.S., C. G. Vosa 2300.

METHOD OF PREPARATION: As in 30.

OBSERVATIONS: In this species there are only two readily visible allocyclic segments distally located on the long arm of the shortest S-chromosome pair.

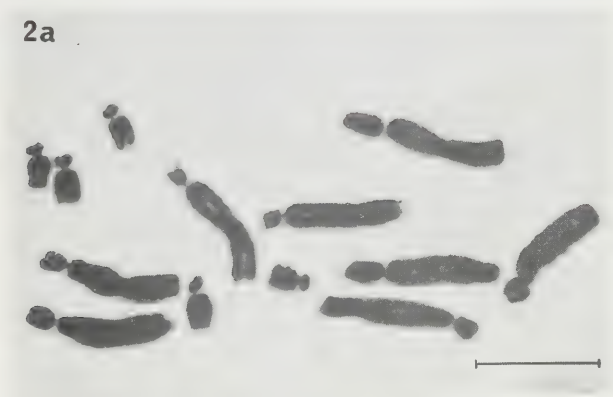


FIG. 2A  
Mitotic metaphase in *Aloe grandidentata* Salm Dyck.



FIG. 2B  
Diagrammatic representation of the haploid karyotype of *Aloe grandidentata* Salm Dyck.

**32. ALOE STRIATA** Haw.

CHROMOSOME NUMBER:  $2n = 14$  (Figs 3a, b).

ORIGIN OF MATERIAL: Hell Poort, Grahamstown, C. G. Vosa 2364.

METHOD OF PREPARATION: As in 30.

OBSERVATIONS: Only two L-chromosome pairs possess allocyclic segments.

**3a**

FIG. 3A  
Mitotic metaphase in *Aloe striata* Haw.

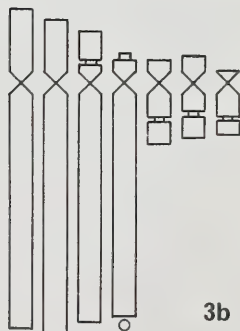
**3b**

FIG. 3B  
Diagrammatic representation of the haploid karyotype of *Aloe striata* Haw.

**33. ALOE ECKLONIS** Salm Dyck

CHROMOSOME NUMBER:  $2n = 14$  (Figs 4a, b).

ORIGIN OF MATERIAL: Keiskamma Hoek, King William's Town, C. G. Vosa 2299.

METHOD OF PREPARATION: As in 30.

OBSERVATIONS: Only one L-chromosome pair has sizeable allocyclic segments.

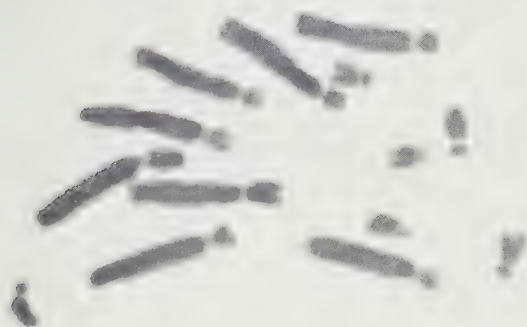
**4a**

FIG. 4A  
Mitotic metaphase in *Aloe ecklonis* Salm Dyck.

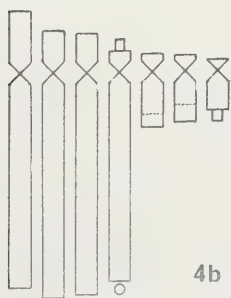
**4b**

FIG. 4B  
Diagrammatic representation of the haploid karyotype of *Aloe ecklonis* Salm Dyck.

**34. ALOE CANDELABRUM** Berger

CHROMOSOME NUMBER:  $2n = 14$  (Figs 5a, b).

ORIGIN OF MATERIAL: Umkomaas Valley, near Ixopo, C. G. Vosa 2298.

METHOD OF PREPARATION: As in 30.

OBSERVATIONS: The L-chromosomes have relatively longer short arms than in other species.

**5a**

FIG. 5A  
Mitotic metaphase in *Aloe candelabrum* Berger.

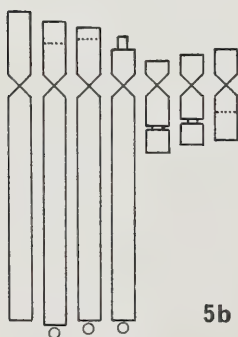


FIG. 5B  
Diagrammatic representation of the haploid karyotype of *Aloe candelabrum* Berger.

**35. ALOE DICHOTOMA** Masson

CHROMOSOME NUMBER:  $2n = 14$  (Figs 6a, b).

ORIGIN OF MATERIAL: On koppies near O'okiep, Namaqualand, C. G. Vosa 2297.

METHOD OF PREPARATION: As in 30.

OBSERVATIONS: Two pairs of L-chromosomes have secondary constrictions located in the distal part of the long arm. This species possesses relatively small allocyclic segments.

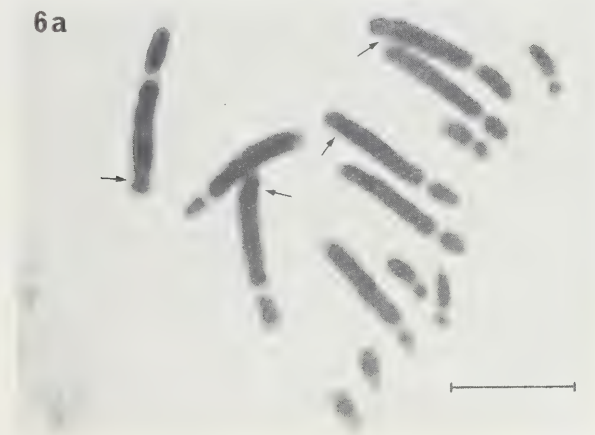
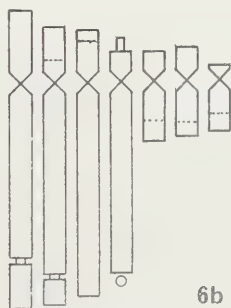


FIG. 6A

Mitotic metaphase in *Aloe dichotoma* Masson. Note the secondary constrictions in the long arms of the first and second L-chromosome pairs (arrows).



6b

FIG. 6B

Diagrammatic representation of the haploid karyotype of *Aloe dichotoma* Masson.



**36. ALOE SPECTABILIS** Reynolds

CHROMOSOME NUMBER:  $2n = 14$  (Figs 7a, b).

ORIGIN OF MATERIAL: Tugela River Valley, Helpmekaar, C. G. Vosa 2302.

METHOD OF PREPARATION: As in 30.

OBSERVATIONS: The karyotypes of the two colour forms of this species (see Reynolds, 1950: p. 479) are indistinguishable.

7a

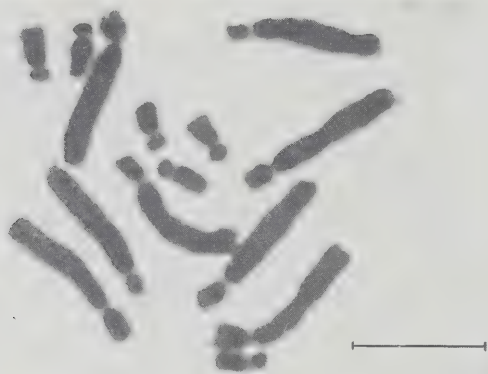
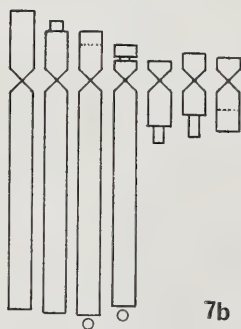


FIG. 7A

Mitotic metaphase in *Aloe spectabilis* Reynolds.



7b

FIG. 7B

Diagrammatic representation of the haploid karyotype of *Aloe spectabilis* Reynolds.

### 37. ALOE RAMOSISSIMA Pillans

CHROMOSOME NUMBER:  $2n = 14$  (Figs 8a, b).

ORIGIN OF MATERIAL: Hells Kloof, N. Namaqualand, C. G. Vosa 2043.

METHOD OF PREPARATION: As in 30.

OBSERVATIONS: One L-chromosome pair has a secondary constriction located in the distal quarter of the long arm.

8a

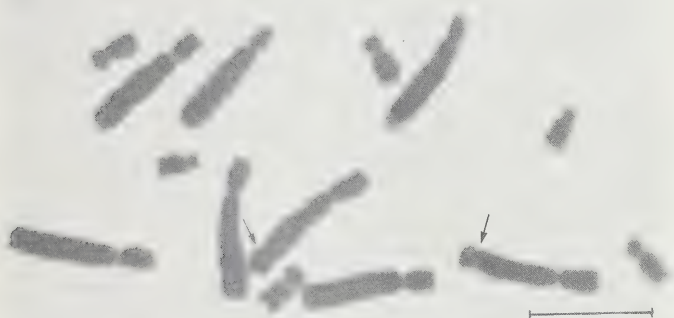
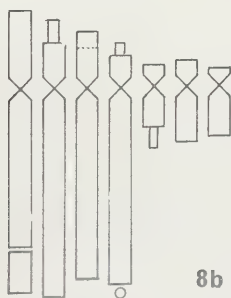


FIG. 8A

Mitotic metaphase in *Aloe ramosissima* Pillans. Note the secondary constrictions in the long arms of the first L-chromosome pair (arrows).



8b

FIG. 8B

Diagrammatic representation of the haploid karyotype of *Aloe ramosissima* Pillans.

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**ALOE DABENORISANA VAN JAARSVELD: A NEW ALOE FROM THE NORTH-WEST CAPE (R.S.A.)**

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**ABSTRACT**

A new *Aloe* species (Liliaceae), allied to *Aloe meyeri*, is described from the North-Western Cape. *Aloe dabenorisana* falls between the series Mitriformes and series Macrifoliae.

**UITTREKSEL**

**ALOE DABENORISANA VAN JAARSVELD: 'N NUWE ALOE VANAF NOORDWES-KAAP (R.S.A.)**

'n Nuwe *Aloe*-soort (Liliaceae) verwant aan *Aloe meyeri*, vanaf Noordwes-Kaap word beskryf. *Aloe dabenorisana* val tussen die reeks Mitriformes en die reeks Macrifoliae.

***Aloe dabenorisana*** E. J. van Jaarsveld, sp. nov.: a *A. meyeri* van Jaarsveld differt, multo maiore acaulescenti planta, crescente nitidis rotundatisque fasciculis, foliis distincte recurvis, inflorescentia 2-4 ramosa atque racemis 120 mm longis et 70-90 mm latis.

*Type:* South Africa: Cape Province—2818 (Warmbad): Dabenorisberg, upper south-western peaks (-DC), *van Jaarsveld and Kritzing* 6426 (NBG, holotype).

*Plants* hanging from vertical south and south-west facing quartz cliffs, acaulescent or short-stemmed, solitary or more often occurring in dense, neat rounded clusters up to 800 mm in diameter. *Stems* up to 300 mm long and 27 mm in diameter, apical part densely foliated. *Rosettes* up to 450 mm in diameter, hanging downwards or ascending, old dry leaves persistent. *Leaves* narrowly lanceolate acuminate up to 240 mm long and 50 mm in diameter, recurved and sometimes deflexed; apices of lower leaves touching the rock face, lower surface convex but keeled towards the apex; upper surface canal-iculate, green tinged with red, becoming more so during severe drought. When green, leaves obscurely striate, when red the striations scarcely visible. Margins armed with small white deltoid teeth  $2 \times 1$  mm,  $\pm 10$  mm apart. Leaf sap drying orange-yellow. When young, leaves are arranged in

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FIG. 1

*Aloe dabenorisana* van Jaarsveld, sp. nov.



4-5 vertical ranks, but later becoming spirally twisted. Inflorescence 250-302 mm long, arcuate and ascending 2-4 branched from the middle or rarely simple. Peduncle flattened, convex up to 12 mm in diameter with few scarious, sterile deltoid acute bracts, 3-4 mm broad. Racemes conical, 120 mm long and 70-90 mm broad. Pedicles 20-28 mm long, shorter upwards. Bracts lanceolate acuminate, thin scarious, 7 mm long and 2 mm broad,

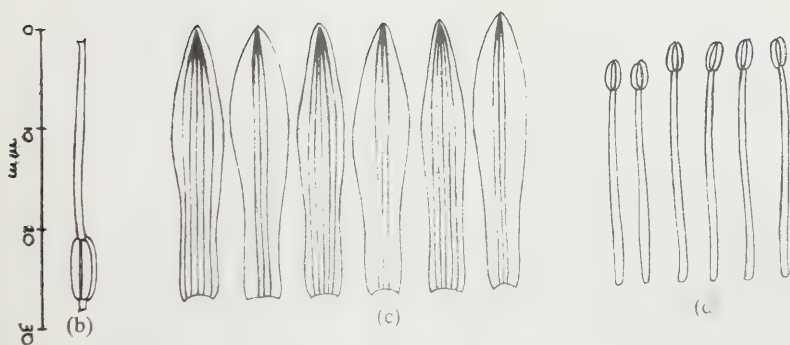


FIG. 2

(a) A juvenile plant. Note that the leaves are in five vertical ranks; (b) gynoecium; (c) segments; (d) filaments.

gradually shortening towards apex, the buds orange, green-tipped, horizontally spreading to subpendulous. *Perianth* 25 mm long, cylindrical, subclavate slightly curved, obtuse or subacute, 5 mm in diameter, proximally widening to 8 mm near mouth, outer segments free, yellowish with a red keel. Filaments yellow, the three inner lengthening before the three outer, flattened at base, up to 3 mm exerted. *Ovary* green, 7 mm long and 2–3 mm broad.

Flowering period: August to November but sporadically throughout the year.

#### DISTRIBUTION

*A. dabenorisana* is as yet only known from the Dabenoris mountain range, which consists of hard quartz and reaches an altitude of 1 078 m at the highest peak. The mountain range is situated in Northern Bushmanland.

#### HABITAT

The plants occur on steep vertical south and south-west facing upper slopes in crevices of quartz rock at an altitude of 900–1 000 m. The plants are locally scattered and not very common.

#### DISCUSSION

*Aloe dabenorisana* is most closely related to *Aloe meyeri* van Jaarsveld. It falls between the series Mitriformes (Reynolds, 1950) and series Macrifoliae which links the two groups together. This new aloe is at once distinguished from *Aloe meyeri* by being a much larger acaulescent plant. The leaves are distinctly recurved, canaliculate and the inflorescences are branched. This species in the young stage shares with *Aloe pearsonii* (series Macrifoliae) the characteristic of having the leaves arranged in 4–5 vertical ranks. In older, larger plants the leaves become spirally twisted. It is also interesting to note that *A. dabenorisana* occurs in Bushmanland which receives summer rainfall. However, the vegetation of the upper quartz rocks in the Dabenorisberg indicates that plants also receive winter rain as it is near the boundary between the two rainfall zones.

*Aloe dabenorisana* was discovered by A. R. Mitchell, a succulent expert from Britain in the course of his survey on the genus *Conophytum*. While climbing the Dabenorisberg on 27 July 1980, in search of conophytums, he came across this unique aloe and at a later stage brought it to the attention of the author.

Earlier this year, Mr. Kobus Kritzinger (Law Enforcement Officer of the Dept. of Nature and Environmental Conservation) kindly took the author to the Dabenorisberg and assisted in collecting the type material. The author



FIG. 3

*Aloe dabenorisana* van Jaarsveld, sp. nov. Habitat.

and Mr. Kritzinger had great difficulty in reaching the plants due to the inaccessibility of the vertical rock face where these plants occur. However, they managed to collect one plant in flower from which this description was prepared.

#### ACKNOWLEDGMENTS

1. Mr. Kobus Kritzinger (Law Enforcement Officer at Springbok of the Dept. of Nature and Environmental Conservation), who very kindly accompanied the author and assisted in collecting the type material and also later together with Mr. van der Westhuizen collected a flowering specimen for illustration.
2. Mr. Anthony Mitchell who discovered this species and supplied the author with valuable information.

3. Mrs. Ellaphie Ward-Hilhorst for her beautiful water colour illustration of *Aloe dabenorisana*.
4. Miss Bosman and Dr. Rourke are thanked for editing the manuscript.
5. Mr. Norval Geldenhuys is thanked for the preparation of the Latin diagnosis.

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SHORT COMMUNICATION

THE REINSTATEMENT OF *TROMOTRICHE* HAW. (STAPELIEAE)

L. C. LEACH

(Botanical Research Institute, Private Bag X101, Pretoria 0001, R.S.A.)

The three species of *Stapelia* L., *S. revoluta* Masson, *S. engleriana* Schlechter and *S. thudichumii* Pillans present a difficult taxonomic problem. Obviously closely related, the three species are yet sufficiently divergent to cause doubts to arise regarding the correctness of regarding them as congeners. All appear to have links with *Orbea* Haw., *Tridentea* Haw., and to a lesser extent with *Stapelia*, while the recent discovery of the rare *S. remota* R.A.Dyer has, in some ways, further complicated the position, as although apparently closely related in its flowers to the controversial trio, it is otherwise wholly *Stapelia* in character, and is therefore retained in that genus.

However, consideration of the remaining three individual species *vis-à-vis* the above mentioned genera, leads to the conclusion that none can be included without introducing an undesirable extent of heterogeneity in genera which are at present, satisfactorily homogeneous.

The possibility of subgeneric status in *Tridentea* to which the three species appear, as a group, to be more closely related than to either *Stapelia* or *Orbea* was also carefully considered but found to be similarly unacceptable.

It has been decided therefore, to resurrect Haworth's *Tromotriche* in which *S. revoluta* has been accommodated since 1812, originally at generic level and subsequently at sectional.

The necessary new combinations are accordingly validated below, full descriptions, discussion and bibliography will be published later.

***Tromotriche* Haw., Syn. Pl. Succ.: 36 (1812).**

Species typica: *Tromotriche revoluta* (Masson) Haw.

***Tromotriche revoluta* (Masson) Haw., Syn. Pl. Succ.: 36 (1812), et Suppl. Pl. Succ.: 11 (1819).—G. Don, Gen. Syst. 4: 119 (1838).**

*Stapelia revoluta* Masson, Stap. Nov.: 12, t.10 (1796).

Lectotype: Masson, Stap. Nov. t.10.

***Tromotriche engleriana* (Schlechter) Leach, comb. nov.**

*Stapelia engleriana* Schlechter in Bot. Jahrb. 38: 49, fig. 8 (1905).

Type: described from a live plant and flowers in spirit (B<sup>+</sup>).

Neotype: S. Africa, Cape, near Laingsburg, Pillans 60 (BOL!).



The original material is assumed to have been destroyed; *Pillans 60* is selected to serve as neotype; the Laingsburg locality was cited by both Berger and N. E. Brown and the flowering specimen in BOL is supplemented by one in fruit under the same number which is also in the Bolus Herbarium.

***Tromotriche thudichumii*** (Pillans) Leach, comb. nov.

*Stapelia thudichumii* Pillans in Jl S. Afr. Bot. **25**: 375 (1959).

Type: S. Africa, Tanqua Karoo, *Thudichum* in Herb. Bolus. 26740 (BOL!).

## BOOK REVIEWS

THE LEGUMINOSAE: A SOURCE BOOK OF CHARACTERISTICS, USES AND NODULATION, by O. N. Allen and Ethel K. Allen, with pp. 812. Macmillan Press, 1981. £35,00.

This substantial volume presents a comprehensive assemblage of data concerning the Leguminosae and could almost be described as an encyclopedia of this large and economically important family of flowering plants. Its authors' aims in producing this work are to meet the need for a comprehensive presentation of generic diagnoses of the family, to provide a review of the uses and value of legumes and to furnish a survey of nodulation scope within the family.

The introductory chapter is a valuable overview of the chief features of the family and the remarkable legume-rhizobium symbiosis which is manifested by so many of its members. Topics discussed include the taxonomy of the family as a whole; the symbiotic process and the evolution of the plant; bacterium association; cross inoculation grouping; root nodule initiation and development; false nodulation and the inability of some genera, notably of the sub-family Caesalpinioideae, to accomplish a symbiotic relationship with *Rhizobium*. The biochemistry of the nitrogen fixing process which is such an important aspect of the symbiosis is not discussed even in elementary form, but references to suitable specialist texts on this topic are given.

In the main part of the work, the 750 known genera of the family have been arranged in alphabetical order and a full botanical description of each genus provided, together with discussion on its taxonomic position, where controversy exists. As the authors point out, the book was in preparation at the time of the International Legume Conference at Kew in August, 1978, so that new taxonomic decisions promulgated at this meeting have not been incorporated in the diagnosis. These changes, such as they are, have only a marginal effect on the value of the taxonomic treatment as a whole.

Each entry also includes the etymology of the generic name, an interesting study in itself, and information on the endemic geographical areas and basic ecological habitats of the members of each genus. Then follows a wealth of information concerning the special features and characteristics of the more important species. This includes discussions of the medicinal uses of the plants, their toxic principals where present, their nutritional value and agricultural usage, their commercial value and their chemical composition where this includes unusual or important compounds. Entertaining historical details concerning the use of these plants by man are often given. We hear, for instance, how *Indigofera* and the dye it produces was responsible for the formation in 1631 of the Dutch East India Company and the political furore it caused in Europe owing to its devastating effect on the entrenched woad industry; and again of the effect of the introduction to Europe of logwood (*Haematoxylon*) on the advancement of cytology; and the use of the seeds of *Abrus precatorius* as standard weights in East Asia (they each weigh a remarkably consistent 0,113 g and were used to obtain the mass of the Koh-i-noor diamond).

Each entry concludes with a survey of the nodulation data available for the genus. This includes the number of species known to be nodulated (with reference to), the type of nodules present and the characteristics of the rhizobia associated with the plants. In this respect it is interesting to note how heavily the authors have drawn on

the valuable information assembled by Professor N. Grobbelaar and his colleagues at Pretoria University. Included in the book is a very comprehensive reference section (1,500 titles), a common name index, and a valuable appendix summarizing the nodulation data.

Illustrations of the leaves, flowers and pods of some 40 species are provided and, more importantly, of the eight types of root nodule featured in the text.

The book has been well produced and entertainingly written, furnishing a wealth of information for taxonomists, physiologists, ecologists, nutritionists, agriculturists, medical physicians, and, indeed, members of the "lay public" interested in this protean and ubiquitous family. It should be of particular interest to South Africans whose homeland is shared so prominently and colourfully by the legumes.

O. A. M. LEWIS

INDEX KEWENSIS SUPPLEMENT XVI, with pp. 1-309. ISBN 0-19-854531-2. London & New York: Oxford University Press, Oct. 1981. £60.

For any alpha taxonomist interested in flowering plants, the publication of another supplement of the *Index Kewensis* must give rise to a feeling of comfortable reassurance, for its very appearance—particularly its bulk—is a symbol that his particular discipline is alive and well.

Seven years have elapsed since the publication of the 15th supplement and the issue of the 16th supplement in 1981 covering the years 1971-1975. One is immediately struck by the fact that the new supplement contains 309 pages, twice as many as the previous three which averaged 148 pages. The principal reason for such a dramatic expansion is that for the first time names of all taxonomic ranks from family downwards are included. In fact the 16th supplement includes all names subject to the principle of priority and the *Rules of the International Code of Botanical Nomenclature*.

Under the circumstances it is remarkable that the Kew staff, responsible for the compilation of this prodigious work, have succeeded in getting it published so soon. Inevitably the cost has risen steeply, from £9.50 for the 15th supplement in 1974 to £60 for the latest supplement. Despite the price, I doubt whether there will be a botanical library anywhere which will not place the purchase of this volume at the top of its priority list.

J. P. ROURKE

PLANT CELL REPORTS, VOLUME 1 No. 1 (An international bimonthly), editors K. Hahlbrock (Europe) and O. L. Gamborg (Countries outside Europe). Springer-Verlag, Heidelberger Platz 3, D-1000 Berlin 33, West-Germany. Vol. 1 No. 1, pp. 1-42. Annual subscription DM 158.

The purpose of this new journal is to obtain rapid communication among all scientists with an interest in plant cell research. In order to ensure rapid publication it is envisaged that camera-ready typescripts be published bimonthly, usually within two to ten weeks from the date a manuscript has been accepted for publication. To

achieve this goal and to ensure a high scientific standard use is made of both an Editorial and an Advisory Board which consist of internationally recognized scientists.

As with all Springer-Verlag publications the general appearance of this journal is pleasing and effective use is made of available space by using two columns on each page.

Volume 1 No. 1 of this publication contains 13 papers of varying length. These first papers are well illustrated and embodied a large number of different disciplines. Noticeable however, is that the bulk of the papers is devoted to the field of tissue culture and/or biotechnology which is expected to play an important role in the "second green revolution".

Any organisation seriously interested in physiology, biochemistry, molecular biology, genetics, and plant breeding as well as the medical/pharmaceutical sciences should have this new journal on their bookshelves. Hopefully the journal will be well supported and will live up to expectations.

J. VAN STADEN

**METABOLISM AND MOLECULAR ACTIVITIES OF CYTOKININS**, edited by J. Guern and C. Péaud-Lenoël, with pp. 352. 1981. ISBN 3-540-10711-8. Obtainable from: Springer-Verlag, Heidelberger Platz 3, D-1000 Berlin 33. US \$44.60.

This book represents the Proceedings of the International Colloquium of the Centre National de la Recherche Scientifique held at Gif-sur-Yvette (France) 2 to 6 September 1980. The contents cover a large number of topics which had been discussed at Biological conferences in recent years. It covers: Cytokinin biosynthesis.—Cytokinin metabolism and physiological responses in plant or bacterial systems.—Cytokinin hormone receptors.—Cytokinin in protein synthesis and RNA metabolism.—Cytokinins and chloroplast development.—Animal systems responding to cytokinin or cytokinin analogs.

While it is essential that this neatly produced book should be on the shelves of all organisations interested in plant physiological teaching and/or research it is nevertheless surprising that more attention was not given to the metabolism of both synthetic and endogenous cytokinins. Particularly, as this aspect features very prominently in the title of the book. Despite this shortcoming the number of important aspects developed makes it a valuable source of information for both undergraduate and post-graduate training. Researchers in the field of plant growth substances and those interested in cell differentiation at the molecular level will find this book invaluable.

Considering its neat outlay, the large number of illustrations, and the quality and relevancy of its contents I feel that this book is reasonably priced and should find wide appeal amongst plant physiologists.

J. VAN STADEN

BIOLOGY OF INORGANIC NITROGEN AND SULPHUR, edited by H. Bothe and A. Trebst, with pp. viii and 384 and 144 figures. ISBN 3-540-10486-0. Berlin, Heidelberg, New York: Springer-Verlag, 1981. Cloth, approx US \$46.80

There are many similarities between the biological cycles of nitrogen and sulphur. Both elements occur in nature in a highly oxidized form and are converted to a very reduced form by organisms in order to enable them to fulfil most of their essential metabolic functions. It therefore is quite appropriate that the biology of the inorganic forms of these two elements are considered together in one book. The contents of the book represents the proceedings of an international conference which was held in Bochum, Federal Republic of Germany, during 1980. As a consequence the different chapters do not interlock as well as can be expected from a textbook.

The chapters are grouped under the following headings: General introduction (one chapter), Nitrogen metabolism in general (three chapters), Dinitrogen fixation (six chapters), Sulphur metabolism in general (six chapters), Contributed papers: Nitrogen Metabolism (eleven chapters), and contributed papers: Sulphur (five chapters).

The general introductory chapter by Schlegel sets the scene in an admirable way and concentrates on the micro-organisms that are involved.

In the section on nitrogen metabolism in general, the chapter by Beevers is disappointing partly because of its superficial nature and partly because it is rather out of date. So for instance, with reference to the *Alnus* type of symbiotic nitrogen fixation systems, he states that "It appears that the symbiont is an actinomycete, however the organism has not been isolated and cultivated in the free-living state". Despite the title of the book, the chapter also contains several pages on amino acid and ureide intermediary metabolism which nevertheless is quite cursory. The other two chapters in this section in contrast, provide a rigorous treatment of assimilatory and dissimilatory nitrate reduction. The former topic, which has received considerable attention in recent years is dealt with comprehensively and contains an extended bibliography.

In the section on dinitrogen fixation, two chapters are devoted to genetic aspects. The one by Brill deals almost exclusively with recent work from his laboratory on *Klebsiella pneumoniae* whilst the one by Heumann concentrates on *Rhizobium* genetics. The latter chapter is written in a very lucid and stimulating style and draws many interesting comparisons between the biology of *Rhizobium* and *Agrobacterium* species. In the chapter by Postgate *et al.* on "Some aspects of the physiology of dinitrogen fixation", the authors restricted themselves to a scholarly presentation of recent ideas concerning three topics, viz. Oxygen as a regulator of nitrogenase, Hydrogenase and the efficiency of *Azotobacter*, and Molybdenum in the regulation of nitrogenase synthesis. The chapter by Zumft on the biochemistry of dinitrogen fixation deals with work published after 1976 and is most informative. In dealing with the regulatory aspects of dinitrogen and ammonium assimilation in nitrogen fixing bacteria, Kleiner *et al.* used a highly condensed style of writing which does not make for easy reading. The very topical subject of the relationship between hydrogenase and nitrogenase in nitrogen fixing organisms is presented expertly by Eisbrenner with special emphasis on what is known for the Cyanophyceae.

The section on general sulphur metabolism contains chapters on assimilatory sulphate reduction, the ecology and physiology of some anaerobic bacteria from the microbial sulphur cycle, the energetic aspects of dissimilatory sulphate reduction, photolithotrophic sulphur oxidation, and the oxidation of ammonia by *Nitrosomonas* and of inorganic sulphur by *Thiobacillus* spp..



Although the subject matter of some of the chapters in the two sections entitled "Contributed Papers" overlap considerably with those mentioned above, most of them are largely complementary. In this regard, special mention should be made of the chapter by Vennesland on the control of nitrate reduction by HCN; by Hess on *in vitro* associations between non-legumes and *Rhizobium*; by Hennecke on a comparison of the regulation of nitrogenase biosynthesis in free-living and symbiotic nitrogen-fixing bacteria; and by Knobloch *et al.* on the thiosulphate-cytochrome c-oxidoreductase enzyme system.

The book contains very few printing errors and the text, generally speaking, is very concise yet lucid. The lists of references varies. In most cases it does not include the titles of the papers as is customary in chemical and biochemical bibliographies. The book contains a wealth of information about some rapidly developing and very important biological topics and it is highly recommended to researchers and post-graduate students who are interested in the relevant topics.

NATHANAËL GROBBELAAR

PHYSIOLOGICAL PROCESSES IN PLANT ECOLOGY, by C. B. Osmond, O. Björkman and D. J. Anderson, with pp. xi and 468, 194 figures and 76 tables. ISBN 3-540-10060-1 Berlin, Heidelberg, New York: Springer-Verlag, 1980. Cloth, approx. US \$57-90.

This book represents vol. 36 of the series on *Ecological Studies* with W. D. Billings, F. Golley, O. L. Lange and J. S. Olson as general editors.

The title of the book is rather misleading. In actual fact, it is a synthesis of virtually all the existing knowledge concerning members of the genus *Atriplex*. Apart from chapters on the systematics and geographical distribution of *Atriplex*, genecological differentiation in general, the genetic and evolutionary relationships in *Atriplex* and the effects of regional environments on *Atriplex* communities, the remainder of the book is devoted to such more truly physiological aspects as seed germination and seedling establishment, the absorption of ions and nutrients, water movement and plant response to water stress, photosynthesis and the influence of environmental factors on productivity—always with the accent on *Atriplex*.

Despite the fact that the book is primarily concerned with *Atriplex*, it should be of considerable interest to many ecologists and plant physiologists because the genus *Atriplex* is a large one encompassing more than 400 species occurring on all continents and many islands between at least N 70° and S 46°. The wide range of the physiological attributes of members of the genus is probably one of the chief reasons why the genus has been studied so extensively in many respects. In this regard the chapters on the mineral nutrition and photosynthesis of members of the genus are especially valuable.

Despite the fact that the book covers a wide range, it presents the reader with a remarkably coherent account which reads easily and contains very few printing errors. Indeed, the presentation and quality of the figures are very good, as is the quality of the paper. A single extensive list of references containing the titles of the relevant papers is provided at the end of the book.

The book will be welcomed by plant physiologists and ecologists in general but also by geneticists interested in *Atriplex*. Although the book will primarily be used by researchers and post-graduate students, its rather high price will probably limit its distribution.

NATHANAËL GROBBELAAR

## 'N VOORSTUDIE IN VERBAND MET DIE EETBARE PLANTE VAN DIE KAMIESBERGE

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### UITTREKSEL

'n Oorsig oor eetbare plante versamel gedurende vroeë lente in die Kamiesberg in die Noordwes-Kaap. Inligting oor voedingswaarde en algemene gebruik word ingesluit.

### ABSTRACT

#### A PRELIMINARY STUDY OF THE EDIBLE PLANTS OF THE KAMIESBERGE

A survey on edible plants collected during early spring in the Kamiesberg in the North-West Cape. Comments on nutrient values as well as common usage are included.

### INLEIDING

Ten spyte van die feit dat Suid-Afrika 'n land is waar voorhistoriese gebruike steeds voortbestaan onder die inheemse mense, is gegewens in verband met hierdie tradisionele gebruike nog nie volledig ter skrif gestel nie. As gevolg van die vinnige veranderende lewensomstandighede kwyn die beoefening van die gebruike sodat kennis van die ou tradisies vinnig verdwyn.

In Namakwaland, die gebied waarbinne hierdie etnobotaniese studie gedoen is, besit die inheemse mense 'n deeglike kennis van die plantegroei van die omgewing. Plante word medisinale en as voedsel gebruik, en die gebied kan dus beskou word as 'n goeie beginpunt vir navorsing wat gemik is daarop om voorhistoriese gebruike in die verband te bestudeer en aan te teken voor dit verlore gaan.

Navorsing is in die Kamiesberge begin, en sal in die toekoms verder uitgebrei na ander dele in die Noordwestelike Kaap.

### 1. NAVORSINGSGBIED

#### 1.1 *Bou*

Die Kamiesberge lê ten noorde van Garies tot sowat 30 km suid van Springbok. Die posisie word aangegee as S 29° 5' en O 18°. Die reël's vorm

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deel van die eskarp van die binnelandse tafelland van Suid-Afrika. Die hoogste rif vorm die eskarp self en verrys met 'n steil helling vanaf die kusvlakte. Die hoogste rif (1 706 m) vorm die eskarp self. Ooswaarts vanaf die hoofrif is 'n reeks van laer riviere wat geleidelik oorgaan in die tafelland van die Boesmanland.

Leliefontein, waar die meeste versamelings gedoen is, is geleë in 'n klein vallei in die middel van die Kamiesberge.

Noord van die dorp lê die Kamiesberg (wat deel uitmaak van die Kamiesberg-reeks) en oos is 'n reeks koppe wat onder verskeie name, soos bv. Kameelkop, bekend staan.

Die bergreeks bestaan uit plato's wat omring is met koppies. Onderskeie plato's word verbind deur begaanbare klowe.

### 1.B Klimaat

Dis 'n winterreënvalgebied en word oor die algemeen gekenmerk deur 'n lae reënval, en a.g.v. die warm klimaat, 'n lae reënvalseffektiwiteit. Maks. reënval gemeet in die gebied was 525,3 mm en min. gemeet was 188,0 mm per jaar. Temperature wissel van 5,6 °C tot 30,5 °C.

### 1.C Plantegroei

Voorlopige studies is gedoen van die plantegroei deur Drège (1829–30), Pearson (1910–11) en Adamson (1938). Laasgenoemde beskou *Elytropus rhinocerotis* as oorheersend; terwyl ander, meer algemene plante, dié volgende is: *Mundtia spinosa*, *Euryops lateriflorus* en *Eriocephalus pubescens*. Acocks (1975) beskou die Kamiesberge-plantegroei as bergrenosterveld. pa/

Studies oor die plantegroei van die gebied is nie voltooi nie, maar die ooreenkomste met die fynbos-plantegroei in die Wes-Kaap is interessant.

### 1.D Bewoners

Simon van der Stel het die "Amacwas" ontmoet tydens sy reis na Namakwaland, en Schapera het die herdersgroepe wat hier woonagtig was as Klein Namaquas gegroepeer. Hulle het geval binne 'n groter groep, die Namas, wat bestaan het uit die Groot Namaquas ten noorde van die Oranje-rivier en die Klein Namaquas in Namakwaland.

Huidig word die gebied bewoon deur blankes sowel as kleurlinge. Bykans alle inligting is verkry vanaf die inwoners wat tradisioneel verbonde is aan die gebied. Teenswoordig is hulle hoofsaaklik woonagtig in die Leliefontein reservaat (Fig. 1), maar hulle dra ook kennis van die plante in die omringende gebiede waar baie van hulle al gewerk het as veewagters. Hulle is afstammelinge van die Khoi-, San- en Bastervolke wat in die gebied woonagtig was gedurende die afgelope 2 000 jaar.

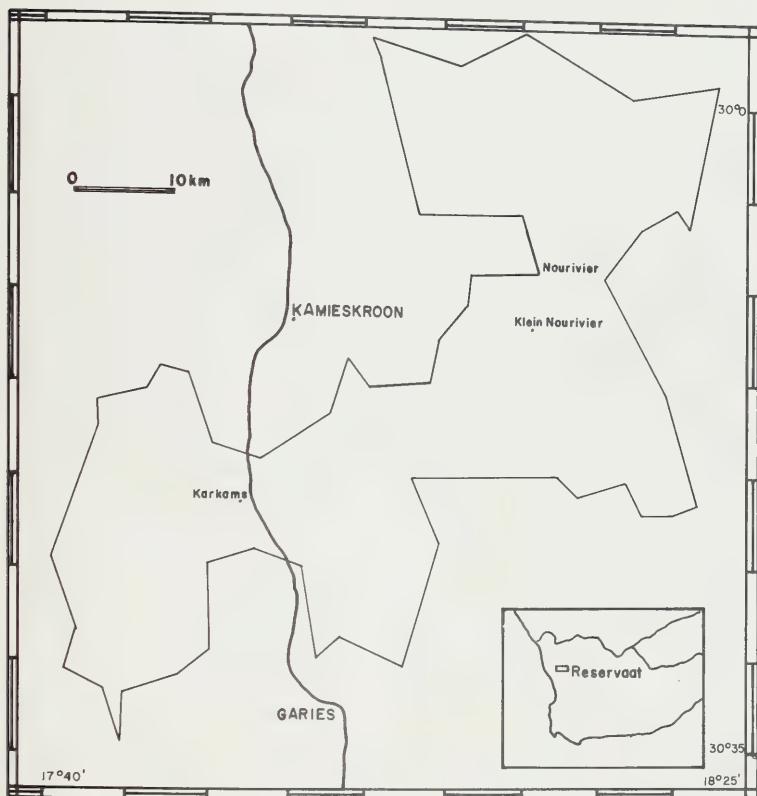


FIG. 1  
Kaart van Leliefontein.

Teenswoordig is die kleurlinge nog verbonde aan sekere tradisies, soos bv. seisoenale migrasies met vee, woon in matjieshutte en versameling van plante as voedsel en medisyne. Baie tradisionele gebruike het ook al verlore gegaan—bv. die praat van Nama, dra van tradisionele klere en eksklusiewe afhanklikheid van die veldplante vir voedsel. Landbou word vanaf 1842 op 'n klein skaal beoefen; en die plan om Leliefontein te onderverdeel in plase sal veroorsaak dat tradisies steeds vinniger verlore gaan.

## 2. NAVORSINGSMETODIEK

Navorsingsmetodiek kan basies onderverdeel word in drie aktiwiteite nl.

### A. Waarnemings in die literatuur



## B. Waarnemings in die veld

## C. Waarnemings in die laboratorium

2.A *Waarnemings in die literatuur*

Ten spyte daarvan dat vroeë reisigers alreeds vanaf die middel 1600's primitiewe gebruike beskryf het, het hul verwysings na plantverbruike nie soveel inligting gebied dat die belang van veldplante in die dieët van die jagter-versamelaars en herdersvolke daarvan afgelei kon word nie. Simon van der Stel se geïllustreerde reisjoernaal bied meer inligting in die verband. Sy toer het hom geneem tot teenaan die Kamiesberge. Kontak met die "Amacguas" daar het gelei tot interessante inligting oor die eetbare plante van hul omgewing. Benewens illustrasies is daar ook 'n lys wat die volgende aangee: Chabi, Canna, Quarombe, Carduu, Thumma, Gammare, Thou (Waterhouse, 1932: 163–168).

'n Ander literêre bron oor die eetbare plante van Namakwaland is geskryf deur Wikar, 'n droster wat gedurende die 1770's gebly het tussen 'n groep Boesmans wat geëet het van die bessies van *Rhus* spp. en *Ziziphus mucronata*. Waarnemings het eersgenoemde bevestig. Kotzé (1942: 238–239) gee 'n kort lys van eetbare plante: Vinkel, Wilde ui, Klipraap, Wilderaap, Wituintjie, Kambro, Suring, Wilde patat, Thom en Kougoed.

Die latere studies het getoon dat die veldplante die belangrikste deel van die vroeë inwoners se dieët uitgemaak het. Die plantdieët is verder aangevul deur die eet van ruspes (Waterhouse, 1932: 163–168; Story, 1958: 24–25), larva van motte (Story, 1958: 25), rysmiere, akkedisse, muise, eiers en vleis van diere (Currlè, 1913: 113–128).

Baie min aandag is tot dusver geleen aan die botaniese identifikasie van die bekende eetbare plante soos genoem in die literatuur. Baanbrekerswerk is gedoen deur Smith (1966), maar inligting is steeds uitstaande.

Aangesien diegene wat nog bekend is met die eetbare plante al bejaard is, is dit noodsaaklik dat intense navorsing gedoen moet word in die gebiede waar die tradisie nog voortbestaan. Die plante kan dan uitgewys en botanies geïdentifiseer word. Sodoende sal die inligting in die literatuur binne 'n botanies-herkenbare raamwerk geplaas word. Waarnemings het verder getoon dat literêre bronne maar slegs 'n klein persentasie van eetbare plante beskryf—dit beklemtoon die noodsaaklikheid van onmiddellike aandag sodat kennis in verband met hierdie gebruike nie verlore gaan nie.

2.B *Waarnemings in die veld*

Veldwerk het geduur vir vyftien dae in September en Oktober 1977 en is hoofsaaklik gedoen in die Kamiesberge. In 1981 het die skryfster teruggekeer na Leliefontein en monsters versamel vir laboratorium ontledings i.v.m. voedselwaardes.

Daar is probeer om sover moontlik van plaaslike inligters onafhanklik van mekaar gebruik te maak en ongeveer 35 persone is ondervra. Altesame 15 persone was bereid om in die veld monsters uit te wys en te verduidelik hoe dit gebruik word. Inligting is op verskeie maniere ingewin.

- (1) Deur bejaarde persone, uitgewys deur lede van die Leliefontein gemeenskap, e.a. te ondervra.
- (2) Deur staptoere in die veld te onderneem en te vra dat alle eetbare plante uitgewys word—hierdie metode was baie suksesvol.
- (3) Deur inligting verkry uit literêre bronne te gee aan inligters en kommentaar uit te ruil.
- (4) Deur deurentyd plante in die veld uit te wys en kommentaar daaroor te vra.

Ondervraging in die veld het geblyk om die meeste inligting te lewer aangesien die waarneming van baie plante geheues verskerp het.

Daar is probeer om soveel as moontlik inligting wat alreeds verkry was, te kontroleer deur vrae te herhaal, en kommentaar te vra van ander inligters. Inligting uit literatuur was ook gebruik vir kontrole.

Gedurende die tydperk van veldwerk was die blomtyd van baie plante verby sodat die plante nie binne genus-spesies raamwerk geplaas kon word nie. Dit het veroorsaak dat geweldige groot afstande afgelê moes word om identifiseerbare planteksemplare te bekom.

Die jong mense, wat nog meer gemaklik in die veld kan rondbeweeg as die bejaardes, het nie so 'n gespesialiseerde kennis getoon van die benutting van die veld soos die bejaardes nie. Kontrole moes dus meer gereeld toegepas word sodat baie tyd vermors is met duplisering van data.

Slegs 'n betroubare lys van die beskikbare plante van een seisoen kon verkry word, aangesien navorsing slegs in een seisoen gedoen is.

## 2.C Waarnemings in die laboratorium

Voedselontledings is gedoen by die Veekunde Departement van die Landbou Fakulteit van die Universiteit van Stellenbosch. Tesame met die inligting i.v.m. digtheid van die eetbare plante lei dit tot 'n meer volledige beeld van die dieëtwaaarde van primitiewe groepe.

Voedselmonsters is volgens die Weende-ontledingskema verdeel in vyf fraksies nl. vog, as, ruproteïen, eterekstrak (vet), en ruvesel. Ontledings van 13 verskillende plante is gedoen. Monsters was nie genoeg om kontrole-ontledings van alle voedsels te doen nie. Waar kontrole-ontledings nie gedoen is nie, word lesings uitgelaat (Tabel 1). Die lae voginhoud van plante wat deur die inligters beskou word as "vaste kosse" is interessant. "Vaste kosse" is kosse wat gou die verbruiker se honger stil. Klipraap, raap, klipuintjie en perdeuintjie het die laagste voginhoud en is geklassifiseer "vaste

kosse". Bogenoemde vier het ook 'n hoë kalorie waarde sowel as 'n redelike proteïen waarde.

*Trachyandra* cf. *falcata* var. en *Grielum humifusum* het die hoogste proteïen waardes; terwyl *Fockea angustifolia* en *G. humifusum* die hoogste voginhoud het. Wanneer voedsel 'n hoë voginhoud het, moet dit in ag geneem word dat baie meer van so 'n voedsel verbruik word om van enige substansiële voedingswaarde te wees.

Toekomstige navorsing sal meer klem lê op voedselontledings en Tabel 1 kan dus gesien word as 'n voorstudie in die verband.

### 3. Die eetbare plante

Planteksemplare is geplaas in plantperse, in FAA en 'n aantal is teruggebring in potte en aan die botaniese tuin in Stellenbosch geskenk. Identifikasies is behartig deur die Staatsherbarium, Stellenbosch. Kontrole-eksemplare van slegs enkele eksemplare is behou in die herbarium, terwyl die orige materiaal in FAA deel uitmaak van 'n versameling van eetbare plante van die Dept. Argeologie van die Universiteit van Stellenbosch.

Inligting van die plante word gebied in die volgende manier: die plante is alfabeties gerangskik binne genus-spesies raamwerk; dan volg die volksnaam; die deel eetbaar; tyd beskikbaar; voorbereiding; kontrole-inligting uit die literatuur en algemene inligting.

Dit is nodig gevind om die plante te onderverdeel in sekere klasse. 'n Verklaring van die terminologie wat gebruik word, volg.

Die reeks plante is verdeel in twee hoofafdelings nl.

Stapelvoedsel

Geleentheidsvoedsel.

#### Stapelvoedsel

Die mees belangrike voedsel-plante waarvan op 'n baie gereelde basis gebruik gemaak word as gevolg van maklike verkrygbaarheid, voedsaamheid, ens.

#### Geleentheidsvoedsel

Dis hoofsaaklik voedsel wat nie stapelvoedsel is nie, en word onderverdeel in vier klasse nl.

- (i) *Aanvullende voedsel*: Voedsel wat terloops versamel word; of wat so 'n kort seisoen het dat dit nie as 'n stapelvoedsel benut kan word nie.
- (ii) *Dorslessende voedsel*: Voedsel wat hoofsaaklik gebruik word om dors te les.
- (iii) *Smaakmiddels*: Voedsel wat hoofsaaklik (nie uitsluitend) gebruik word as 'n smaakmiddel.
- (iv) *Lekkernye*: Voedsel wat hoofsaaklik in die veld geëet word as 'n lekkerny.

*Acacia karroo* (doringboom, widdoring)

Die eksudasie van die boom is eetbaar en is algemeen bekend as Kaapse gom. In Namakwaland noem die plaaslike inwoners dit *hyra*. Dit is dwarsdeur die jaar beskikbaar en word as volg voorberei: 'n dag of twee voordat die gom geëet word, word 'n kerf gesny in die bas. Liggoud gom drup dan uit en word "gepluk" wanneer dit effens hard is. Palmer en Pitman (1961) skryf dat die voedselverbruik van die gom 'n baie populêre gebruik is by die natuurle. Vervet ape smul ook aan die gom. Watt en Breyer-Brandwijk (1962: 545) beweer dat Tlhaping kinders dit graag gebruik as soet vleis.

Alhoewel die gom eintlik as 'n lekkerny beskou kan word, is die belang van die *Acacia karroo* vir die plaaslike inwoners baie groot. In die somer trek die geurige klein geel blommetjies bye aan—en vroeë Hottentotte het dikwels genoem dat die heuning dan volop is (Palmer en Pitman, 1961: 157). Verder groei die parasiet *Moquinella rubra* (kootjie -nam-nam) op die *Acacia karroo*. Die klein rooi-oranje vrugte van die parasiet is eetbaar vanaf die einde van September tot die begin van Desember. Behalwe dat die boom voedsel bied aan die mens, vorm die peule en blare voeding vir vee—'n belangrike oorweging by immigrasie-roetes van vroeë herdersvolke.

Die groen jong lote word ook deur die Nama herdersvolke gebruik om die raamwerk van hul hutte en kookskerms te vorm, terwyl droë hout as vuurmaakhout gebruik word.

TABEL 1.  
Lesings van voedselwaardes op 'n vogvrye basis

Volksnaam	% Vog- inhoud	% As	% Rupro- teien	% Ruvesel	% Vet	kJ/g
Raap .....	54,9	1,58	6,88	3,86	1,44	16,36
Klipraap .....	46,2	1,28	4,05	3,72	—	17,38
N/eitjie .....	61,0	0,26	3,65	3,85	0,72	16,57
/Oertjie .....	72,4	3,31	5,27	0,46	—	17,12
Waterbaro .....	78,9	2,98	5,74	3,19	—	—
Melkbaro .....	77,4	2,49	3,15	—	4,82	17,29
Klipuintjie .....	49,2	1,73	3,53	1,59	—	16,54
Perdeuintjie .....	47,4	2,08	4,48	0,97	—	16,45
Kool .....	86,3	10,55	15,28	—	5,29	17,25
Piet Snot .....	82,6	1,48	6,20	8,49	—	14,25
Makuintjie .....	89,8	1,77	5,91	1,61	0,99	16,28
Kamro .....	90,0	0,10	5,11	16,24	5,23	15,98
Suurskil .....	58,7	7,34	10,73	26,63	5,23	16,31
*Aartappel .....	—	4,5	10,4	2,5	0,5	15,73

\* Waardes geneem van *Composition of Foods*. Agriculture Handboek No. 8. U.S. Dept. of Agriculture, Washington D.C. 1963.

Die voorkoms van hierdie baie algemene boom, wat ook gewoonlik in droeë rivierlope voorkom, is dus van groot belang vir enige ekologiese studies.

*Albica altissima* (slymstok)

Die onderste ligroos gedeelte van die slymstok se steel word geëet gedurende September en Oktober. Die blare word afgetrek, die boonste gedeelte met die blomme word afgebreek en die steel dan rou geëet. Inligters het genoem dat die steel, wat 'n soet waterige smaak het, gebruik word om dors te les.

*Arctotheca calendula* (soetgousblom)

Die stingeltjie van die plant is eetbaar terwyl dit blom vanaf Augustus tot einde Oktober. Die soet sap word uit die steeltjie gesuig. Dis 'n dorslesende voedsel.

*Babiana ambigua* (poepuintjie)

Die gerokte knolletjies is eetbaar vanaf Julie tot September. Die losserige rok word afgetrek as die uintjie rou geëet of in melk gekook word. Wanneer dit gerooster word, word 'n gat in die grond gemaak, die warm kole en uintjies en sand ingegooi en die rok nie afgehaal nie.

Die genus *Babiana* is vasgestel in 1802 deur Ker, wat die naam afgelei het van "Babianer". Die naam is aan plante gegee omdat die knol 'n gunsteling maaltyd vir bobbejane is (Lewis, 1959: 7). Laasgenoemde is van belang aangesien dit veronderstel word dat plantvoedsels wat deur bobbejane benut word waarskynlik deur vroeë inwoners ook gebruik was. Vier verskillende eetbare *Babiana* spp. vanaf die Kamiesberg is geïdentifiseer.

*Babiana dregei* (klipuintjie)

Die knol van die plant is 'n gunsteling by alle inligters. Dit word gewoonlik geëet of gekook na dit gepluk is (Julie–Augustus), maar blykbaar "droog die bol uit" in September en Oktober sodat dit meer aangenaam is om dit dan rou te eet.

*B. dregei* is baie volop in die Kamiesberg. By Nais het 31 trosse binne 10 m<sup>2</sup> voorgekom. Die plant kom egter voor in klipskeure en is dus soms onmoontlik om te benut. Desnieteenstaande kan dit, tesame met ander eetbare plante, beskou word as 'n stapelvoedsel. Die voginhoud (Tabel 1) is relatief laag en dit word as 'n vaste kos beskou.

*Babiana hypogea* (perde-uintjie)

Die knol is eetbaar Julie tot Oktober en word op dieselfde manier as *Babiana ambigua* voorberei en benut. Burchell (1822) het geskryf dat die



Tswanas en die Tlhaping die bol van *Babiana hypogea* eet. Die voginhoud van die bol is baie laag.

*Babiana namaquensis* (draai-uintjie)

Die knol is eetbaar tydens Julie tot Oktober en word op dieselfde manier benut as ander *Babiana* spp. Hierdie uintjie word herken aan sy spiraal blaartjies. Dit groei in klipperige grond en het 'n baie klein bolletjie. Dus was inligters nie baie entoesiasies oor die benutting van die bolletjie nie.

*Caralluma mammillaris* (aruna)

Die sappige vingeragtige uitgroeisels is eetbaar vanaf Junie tot Augustus. Die dorings word afgesny en dan word die stukkies rou geëet. Die saadpeule is eetbaar in Augustus en staan, soos *Microlooma sagittatum*, bekend as bokhorings. Smith (1966: 64) bevestig die eetbaarheid van die plant.

*Carpobrotus* spp. (hotnotsvye)

Die vrug is eetbaar gedurende Desember en Januarie. Smith (1966: 251) skryf dat die vrugte van *C. edulis* eetbaar is. Eksemplare verwyder uit die Kamiesberg was egter ongeïdentifiseer as gevolg van die feit dat hulle nie geblom het nie. Die vrug word beskou as 'n lekkerny.

*Conium* spp. (vinkel, perdevinkel)

Twee *Conium* spp. kom voor in die Kamiesberge. Plaaslik staan hulle bekend as perdevinkel en vinkel. Die wortel word rou geëet. Die lekkerny is beskikbaar vanaf Julie tot Oktober. Kotze (1943: 239) maak melding van vinkel. Die eksemplare was nie identifiseerbaar binne spesies raamwerk nie. Plaaslike inwoners onderskei tussen die twee as volg: perdevinkel is groter as vinkel. Die wortel of vinkel het 'n baie sterk aangename geur (soos klap-per), terwyl die van perdevinkel omtrent geen geur het nie.

*Cyanella hyacinthoides* (raap)

Die knol is eetbaar vanaf Julie tot Oktober en word geëet soos die *Babiana* spp. Gaar word dit ook soms fyn gemaal en met melk aangebied. Marloth (1917) noem dat die eetbare *Cyanella* spp. in Namakwaland ook bekend staan as uintjies. Thunberg (1795) het *C. hyacinthoides* raaptol genoem. Hierdie plant kan beskou word as 'n stapelvoedsel in die dieët van die vroeë inwoners van die Kamiesberge. Raap is baie volop en dit is bekend dat "emmers vol" vroeëre jare uitgehaal is. Die raap is veral volop op ou lande waar tot soveel as nege per m<sup>2</sup> getel is. By 'n onversteunde lap grond by Nais is 3 rape, 1 skaapsuring (*Oxalis copiosa*) en 164 makuintji (*Oxalis* spp.) opgemerk binne vyf m<sup>2</sup>. Die knol het 'n lae voginhoud en baie

hoë kalorie-waarde. Elke knol weeg ongeveer 14 g nadat dit skoongemaak is. Dit kan as 'n hoë kwaliteit voedsel beskou word.

*Cyanella* sp. (klipraap)

Verwys na *C. hyacinthoides*. Die verskil is dat die klipraap slegs tussen die klippe voorkom, en geensins so volop soos *C. hyacinthoides* is nie.

*Cyphia sylvatica* (melkbaroe)

Die wortelstok word versamel tydens Julie tot in Oktober. Die stingeltjies en skil word verwyder en die baroe word dan rou geëet of gerooster. Simon van der Stel het genoem dat *Cyphia* spp. daaglik geëet word deur die Namavolke (Waterhouse, 1931: 831). Hieruit kan afgelei word dat die *Cyphia* spp. 'n stapelvoedsel was. Inligters het gevoel dat die rou wortelstok as dorslessend beskou kon word. Laasgenoemde word ondersteun deur ontledings wat wys daarop dat die voginhoud baie hoog (77,4 %) is. Binne 'n radius van 5 m het 11 plante voorgekom (Nourivier gebied).

*Cyphia volubilis* (waterbaroe)

Word geëet en voorberei op dieselfde manier as die melkbaroe. Hierdie spesies word egter as meer skaars beskou, en in die gebied bestudeer is dit nooit gevind in sandgrond soos *C. sylvatica* nie. Inligters onderskei die twee spesies van mekaar op grond van die melkerige vog in *C. sylvatica* wat anders is as die waterige vog in *C. volubilis*. Smith (1966: 86) maak melding van die eetbare spesies. Verder skryf Watt en Breyer-Brandwijk (1962: 157) van die gebruik van *Cyphia volubilis* deur die naturelle. Beide kosse word herken aan die moeilik sigbare fyn stingeltjies wat rank in ander bosse. Die vleis van hierdie spesies is so gewild dat lokasies van die plante gemerk word sodat hulle later makliker opgespoor kan word. Dit kan beskou word as 'n stapelvoedsel wat ook (rou) 'n dorslessende funksie gehad het (sien Tabel 1). By Nourivier is vier plante binne 'n radius van 10 m opgemerk.

*Diospyros* sp. (kanobie)

Die bessies van die plant is eetbaar vanaf Oktober tot begin Desember. Volgens Van der Stel proe die bessie baie na 'n Indiese plant "kouki" en indien te veel geëet word, veroorsaak dit hardlywigheid (Waterhouse, 1932: 167). Volgens die inligters is alle bosse se bessies wel eetbaar, maar almal is nie ewe smaaklik nie. By Nourivier is 21 bosse binne 'n 10 m radius getel.

*Euphorbia brachiata* (soetmelkbos)

Die eksudasie van die bos is dwarsdeur die jaar eetbaar. 'n Takkie word geknak en die wit melkerige sap in die takkies kom na vore. Na 'n dag vorm

dit 'n taaierige gom. Gerugte wil dat die gestolde sap van die soetmelkbos lank terug deur die Boesmans van die Kamiesberg gekou is wanneer hulle lang ente gaan draf het. Dit het verhoed dat hulle monde droog en hul tonge dik word. Watt en Breyer-Brandwijk (1962: 402) bevestig inligting dat die soetmelkbos dwarsdeur die jaar voeding is vir diere.

#### *Fockea angustifolia* (kamro, kambro)

Die wortelstok van *F. angustifolia* word geëet vanaf Julie tot ongeveer Oktober. Dit is eetbaar dwarsdeur die jaar, maar die dun stingeltjie wat gewoonlik rank in ander bosse, verdroog, en dan is dit nie meer sigbaar nie, sodat slegs dié wat gemerk was, geëet kan word. Blykbaar verander die smaak dan ook effens, en is die kamro ook pap—nie so aangenaam om te eet nie. Burchell het van hierdie kos geskryf: "It is a fortunate recourse for a thirsty traveller" (Smith, 1966: 89).

In sy *Dagregister* skryf Simon van der Stel dat die wortel (ondergrondse steel) van die kamro gesuig word, en dat dit baie verfrissend is (Waterhouse, 1932: 167). Die eetbare wortelstok is ook goed bekend by hedendaagse bevolkings. Op Robertson se skou, 1977, is melding gemaak van 'n *F. angustifolia* wat 213 g geweeg het (Die Burger, 26 September 1977). Van die kamro's uitgehaal deur inligters het baie gewissel in grootte—kamro's afkomstig van een stingel het 942 g geweeg. Die inligters het onderskei tussen soet kamro's wat voorkom in klipperige grond en effens bitter kamro's wat voorkom in sandgrond, maar geen monster van die bitter kamro's is uitgewys nie. Hulle het dit genoem dat die nadeel van die "soet kamro", is dat hy "om die klippe kruip". Dit maak dit baie moeilik om die dun broos stingeltjie wat lei na die kos, te volg.

Die wortelstok is 'n geleentheidvoedsel en die hoë voginhoud (90%) veroorsaak dat dit 'n gunsteling is om dors te les.

#### *Gazania krebsiana* (botterblom)

Die soet blomstingel word geëet vanaf Julie tot Augustus. Dit het 'n bedwelmende uitwerking op die verbruiker. Kan beskou word as 'n lek-kerny.

#### *Grielum humifusum* (piet snot)

Die sappige en effens slymerige wortel word versamel vanaf Junie tot Oktobermaand. Sand word van die wortel afgevruf en dit word rou geëet. Versamelaars beskou hierdie wydverspreide en volop plant as 'n belangrik, dorslessende voedsel. *G. humifusum* word geëet deur die vee ook. Dit het tot gevolg dat beweide grond beswaarlik 'n opkoms van *G. humifusum* toelaat in teenstelling met onbeweide gebiede waar dit in plate voorkom. Interes-

sant i.v.m. hierdie plantvoedsel is dat dit 'n baie hoë ruproteïen-inhoud (10,72 %) toon; sowel as 'n hoë voginhoud.

*Hesperantha* sp. (suurskil)

Die lang blare van die plant word gekou in die wintermaande Julie tot Augustus. Dit is 'n lekkerny en 'n smaakmiddel by bredies.

*Hexaglottis longifolia* (swartuintjie)

Die knol is eetbaar vanaf Augustus tot November. Dit word rou geëet, gekook in melk, of gebraai, en is 'n gunsteling omdat dit maklik herkenbaar is aan die lang grashalmagtige blaar; en baie maklik is om uit die sanderige grond, waarin dit voorkom, te verwyder. Die swartuintjie kan beskou word as 'n stapelvoedsel. In ander dele van die land staan hierdie uintjie bekend as volstruisuintjie—so benoem as gevolg van die feit dat volstruise dit graag eet (Smith, 1966: 488).

*Hyobanche sanguinea* (waspop)

Die wortel-parasiet se sap, word uitgesuig deur die kinders, wat ook graag speel met die plant. Dit is 'n lekkerny.

*Massonia depressa* (ouma se jampot)

Die geel blom huisves 'n soet stroop wat 'n gunsteling is by kinders vanaf Augustus tot einde September. Dit kan as 'n lekkerny beskou word.

*Mesembryanthemum* sp. (soutslaai)

Die sout blare van die volop plant word as smaakmiddel gebruik in bredies, vanaf Julie tot die begin van Desember.

*Microloma sagittatum* (bokhorings)

Die jong kokervrugte is eetbaar vanaf Julie tot laat September en word gepluk en rou geëet in die veld. Dit kan beskou word as 'n lekkerny.

*Moraea viscari* (uintjie)

Die klein knolletjie is eetbaar vanaf einde Julie tot Oktober. Dit word gewoonlik gekook om ontslae te raak van die swart vloeistof daarin. In sommige gebiede staan dit bekend as teeruintjie (Smith, 1966: 458).

*Moquinella rubra* (kootjie -nam-nam)

Die bessies word geëet vanaf einde September tot begin Desember (sien *Acacia karroo*).

*Oxalis copiosa* (skaapsuring)

Die blom en stingel is eetbaar vanaf einde Junie tot einde September. Dit word rou geëet maar is ook 'n gunsteling by die bereiding van bredies van enige soort. As sulks word dit beskou as 'n baie belangrike smaakmiddel. Minder algemeen word dit saam met melk as 'n pap geëet. Die plant is baie volop.

*Oxalis* cf. *tricolor* (bobbejaanuintjie)

Die knol is eetbaar vanaf Julie tot September en dit word rou geëet, ge-rooster in as of met melk geëet. Die knolle is baie maklik om uit te haal en is 'n gunsteling by bobbejane en voëls.

*Oxalis* sp. (makuintjie)

Word versamel vanaf Oktober tot einde November en voorberei soos ander *Oxalis* spp. Volgens die inligters is dit 'n belangrike stapelvoedsel wat baie volop is. (Sien *Cyanella hyacinthoides*). Toetse in die laboratorium het getoon dat die makuintjie 'n geweldig hoë voginhoud (89,8%) het. Dit sou beteken dat baie van die bol versamel sou moes word om genoeg vaste voeding te verskaf. Die bol is verder ook nie baie hoog in voedingswaardes nie (Tabel 1).

*Pelargonium carnosum* (kaan)

Die takkies is eetbaar tydens Junie–November. Die groen bas-velletjies word afgetrek en dan word die suikersoet takkie rou geëet. Dis 'n lekkerny.

*Pelargonium incrassatum* (n/eitjie)\*

Saam met raap is die 'nyttjie die mees gewilde knol onder versamelaars. Van hierdie droeë persagtige knolletjies word soveel as moontlik bymekaar gemaak vanaf einde Junie tot in Oktober. Die knolletjies word rou geëet, of voorberei in melk of gebraai in as. Die gewildheid van die knol lê ook daar-in dat dit so maklik bekombaar en volop is.

*Pelargonium pulchellum* (n/pita)

Die knolletjies word versamel vanaf Julie tot Oktober. Die knolletjies word altyd gaar geëet.

*Pelargonium rapaceum* (/oertjie)

Die verdikte wortels word versamel vanaf Julie tot Oktober en is 'n groot gunsteling by versamelaars omdat dit so heerlik proe, maklik verkryg-

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\* 'n Dwars streep ( ) dui 'n kliek-klank in algemene spreektaal van die omgewing se inwoners aan.



baar is en so groot is. Dit word gewoonlik gerooster in as en dan word die harde basagtige vlies afgetrek voordat dit geëet word. Smith (1966: 352) verwys na die gebruik van *P. rapaceum* (norra) deur die vroeë Hottentotte. Hulle het dit vir voedsel sowel as medisyne benut. As voedsel vorm dit deel van die lys van stapelvoedsels. Dit het 'n hoë kalorie waarde.

#### *Pelargonium triste* (wit n/eitjie)

Die effens rooikleurige stingeltjie word gedurende Augustus tot Februarie bymekaar gemaak en word benut as 'n aanvullende voedsel, medisyne sowel as 'n kleurmiddel. Die knol word gerooster, maar is nie 'n gunsteling onder inligters nie. Watt en Breyer-Brandwijk (1962: 455) het ook bevind dat die stingelknol benut word as voedsel, sowel as maagmedisyne. In die Kamiesberge, en ander dele van die Leliefontein reservaat, word die knol gebruik om leer donkerder te kleur.

#### *Rhus horrida* (taaibos, njarabessies)

Die klein, ronde, plat vruggies word gepluk wanneer dit bruinrooi is—gewoonlik vanaf September tot Desember. Die vruggies word gevryf tussen die hande sodat die bruinrooi velletjie afval, en dan word dit as lekkerny geëet; of dit word oornag geweek in melk sodat dit 'n pap vorm. Dikwels word suring by die pap gevoeg.

Die vrugte van *Rhus* spp. word in die algemeen as eetbaar beskou en bekende name wat daaraan gegee word, is rosyntjebos, korentebessies en kraaibessies. Pitman en Palmer (1972: 1225) noem dat die vrugte nie alleen in die verlede nie, maar huidig nog 'n belangrike deel van die dieet van die Khoisan en Bantoesprekende volke gemaak. Watt en Breyer-Brandwijk (1962: 50) noem dat die Bantoesprekende volke die blare medisinaal gebruik as 'n teenweer vir borssiektes.

*Rhus horrida* is baie volop in die Kamiesberge, en aangesien dit nie net as voedsel benut word nie, vorm dit, net soos *Acacia karroo*, 'n baie belangrike element in die bestaanseconomie van huidige herdersvolke. Die hout is van 'n baie goeie kwaliteit vir vuurmaak, en word baie dikwels daarvoor gebruik. Laasgenoemde is in teenstelling met die Xhosas wat voel dat die hout, wanneer dit kners en knetter in die vuur, weerlig aantrek (Palmer en Pitman, 1972: 1226). Die takke word benut by die oprigting van matjieshuise. In die verlede was die harde bas gebruik om tou mee te maak (Schonland, 1896: 8) en volgens Palmer en Pitman (1972: 1226) is mandjies en kieries gemaak van die bas; en het die Boesmans vroeër jare hierdie hout gebruik om hul boë mee te maak.

*Trachyandra* cf. *falcata* var. (hotnotskool)

Wanneer die blomme nog nie bloei nie—vanaf Julie tot September—word die jong kwaste gepluk. Voorbereiding vir 'n maaltyd vind plaas deur die kwaste te kook saam met vleis, aartappels en suring. In ander gebiede word die kwaste op dieselfde manier benut (Smith, 1966: 251). Die kool is nie vir 'n baie lang tyd beskikbaar nie, maar is, volgens inligters, volop in die regte tyd. Interessant is die hoë proteïen-inhoud van die plant (15,28 %) en die hoë kalorie waarde. *Trachyandra* cf. *falcata* var. kan beskou word as 'n aanvullende voedsel met 'n baie goeie voedingswaarde.

*Watsonia* spp. (suurskil)

Sien *Hesperantha* spp. word op dieselfde manier benut. Hierdie voedsel het 'n geweldige hoë ruproteïen inhoud. Sien Tabel 1.

*Slot*

Inligting verkry uit die afgehandelde navorsing bied nuwe feite i.v.m. die verskeidenheid en voedingswaardes van plante wat gebruik word as voedsel. Verdere navorsing is egter noodsaaklik voordat 'n geheelbeeld, en verklarings i.v.m. stapel/ en geleentheidsvoedsels oortuigend ontwikkel kan word.

*Navorsingsplanne vir die toekoms sluit die volgende in:*

- A. Onderzoek na die verkrygbaarheid van plantvoedsels gedurende verskillende seisoene. Die bestaande inligting is verkry deur studies wat gedurende die vroeë lentemaande onderneem was, en dit is van belang dat 'n volledige lys van beskikbare plante vir die gebied verkry word.
- B. Onderzoek na die verkrygbaarheid van eetbare plante in die aangrensende gebiede. Leliefontein is die gebied met die hoogste reënval in Namakwaland. Omringende gebiede het baie plante in gemeen, maar dit lyk asof die plante nie op dieselfde tye beskikbaar is nie. Dit sou interessant wees om die Richtersveld te besoek om vergelykende studies uit te voer. Die Leliefontein-reservaat grens aan die Boesmanland wat 'n somer-reënval gebied is. Die verwagting is dat sekere groepe gedurende die droë somermaande daarheen sou immigrer, en dit is dus van belang om dié gebied te bestudeer.
- C. Ontledings sal gedoen word van alle beskikbare voedselplante sodat die dieëtwarde van vroeëre bewoners bepaal kan word. In samehang hiermee sal die groeisyklusse van die stapelvoedsels bestudeer word om te kan vasstel vir watter periode dié plante beskikbaar was, en dié daar noemenswaardige verskille in voedingswaardes bestaan gedurende verskillende seisoene.

Aangesien die tradisionele gebruike en kennis daarvan baie vinnig besig

is om te verdwyn, is dit van groot belang dat navorsing so gou as moontlik afgehandel word.

Inligters is al bejaard, en die jonger geslag stel nie belang in die behoud van tradisionele gebruike nie. Die besluit om Leliefontein in 36 plase te verdeel, en die daarmee gepaardgaande ontmoediging van tradisionele lewenswyses dra daartoe by dat tyd beskikbaar vir vrugtevolle navorsing baie beperk is.

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## THE APPLICATION OF THE NAME *BLECHNUM CAPENSE* BURM.F.

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### ABSTRACT

The application of the name *Blechnum capense* Burm.f. is discussed and a lecto-type is proposed for this taxon.

### UITTREKSEL

DIE GEBRUIK VAN DIE NAAM *BLECHNUM CAPENSE* BURM.F.

Die gebruik van die naam *Blechnum capense* Burm.f. word bespreek en 'n lektotipe word vir die betrokke taxon voorgestel.

### DISCUSSION

Schelpé (1979) proposed the new name, *Blechnum sylvaticum*, for the taxon more widely known as *B. capense* (L.) Schlechtend.

In 1768 the younger Burmann published the name *Blechnum capense*. Although the name was validly published, Christensen in his *Index Filicum* (1905), cited it as "nomen = *B. australe* L."

Three years later (1771), the name *Osmunda capensis*, based on a Koenig collection from the Cape, was published by Linnaeus. Until recently, Christensen's treatment, with Linnaeus as the authentic author of *B. capense* was widely accepted.

The identity of *B. capense* Burm.f. however remained questionable. When Schelpé studied collections in the Burmann herbarium at Genève, material of the species involved was apparently not available. In 1979, Mr. Linder, a student of orchidology, produced a photograph on request of Schelpé, of what appeared to be the type of *B. capense* Burm.f. Burmann's handwriting does not appear on the sheet, but a note in the hand of Houttyn reading "*Blechnum capense* appellavit N. L. Burmannus . . .", is pinned to the sheet. This consists of a mixed collection. The description given by Burmann is brief and as stated by Schelpé, can apply to any of the two species on the sheet. For this reason and on the fact that the epithet "*capense* L." is illegitimate in being superfluous, Schelpé based his argument and proposed the new name *B. sylvaticum*.

However, Linder failed to find a second sheet of *Blechnum* in the Burmann herbarium. This sheet contains fertile and sterile material of *B. ca-*

*pense* (L.) Schlechtend. The name *Osmunda capensis* appears several times on the sheet, but none of them are in the hand of Burmann. The name *Acrostichum sorbifolium*, in the hand of Montin, as well as a determination slip of Schelpe reading "*Blechnum capense* (L.) Schlechtend. 1967", appear on the sheet. Burmann's brief description can also apply to this specimen.

Although Houttyn writes "appellavit N. L. Burmannus", the second sheet cannot be ignored. Clear annotations on both sheets show that they originally formed part of the Burmann collection. A further annotation on the sheet shows that Delessert, purchaser of the Burmann herbarium, later incorporated it into his herbarium.

In accordance with the *International Code of Botanical Nomenclature* (Article 7.5 and Recommendation 7B), the author proposes that the sheet determined by Schelpe as *Blechnum capense* be regarded as lectotype of *B. capense* Burm.f. (Fig. 1).

The correct citation of Burmann's species is therefore as follow:

***Blechnum capense*** Burm.f., Fl. Cap. Prodr. in Fl. Ind.: 28 (1768). Type: Cape (G, lectotype!).

*Osmunda capensis* L., Mant. pl. Alt.: 306 (1771). Type: Habitat inter montes Cap b. Spei, inter montem tabularem et Diaboli, ad rivulum. *Koenig* 22 (LINN 1244/II, holotype!).

*Blechnum capense* (L.) Schlechtend., Adumbr.: 34, t.18 (1825).

*Blechnum sylvaticum* Schelpe, Jl S. Afr. Bot. **45**(2): 221 (1979). Type: As for *Osmunda capensis* L.

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*Jl S. Afr. Bot.* **45**(2): 221.



FIG. 1.  
Lectotype of *Blechnum capense* Burm.f.



## DISTRIBUTION AND SPECIES RICHNESS OF TREES IN SOUTHERN AFRICA\*

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### ABSTRACT

A phytochorology for southern Africa is derived, based exclusively on species of trees. Cluster analysis, multi-dimensional scaling and information statistic tests are applied to isolate and characterize assemblages of tree species. Six major tree provinces, three of which contain a number of subprovinces, are recognized in a two-tier classification scheme. This phytochorology is compared with classification schemes based on subjective decisions and qualitative information. Correlation and regression analyses involving a suite of environmental variables are used in examining hypotheses concerning an increase in species richness with a decrease in geographical latitude, and a decrease in species richness with an increase in aridity.

### UITTREKSEL

#### DISTRIBUSIE EN SPESIERYKHEID VAN BOME IN SUIDELIKE-AFRIKA\*

In hierdie artikel word 'n fitochorografie vir Suider-Afrika voorgestel wat uitsluitlik gebaseer is op boomspecies. Groepe boomspecies word onderskei en gekarakteriseer deur middel van groeipanalises, multidimensionele gradering en die toepassing van statistiese inligtingstoetse. Ses hoofboomgebiede waarvan drie in aantal subgebiede insluit, word onderskei. Die voorgestelde fitochorografie word vergelyk met klassifikasiesistelsels wat op subjektiewe beslissings en kwalitatiewe informasie gebaseer is. Korrelasie- en regressieanalises wat 'n stel omgewingsveranderlikes behels, word gebruik om hipoteses oor 'n toename van spesierykheid met afnemende geografiese breedte en 'n afname van spesierykheid met toenemende dorheid te ondersoek.

### INTRODUCTION

Southern African phytochorological studies (reviewed by Werger, 1978) tend to rely on unspecified data bases, and the criteria used to delimit phytochoria have frequently been undefined. Here we report a phytochorology for southern Africa based, for the first time, exclusively on trees, and modern analytical methods. In discussing the derived patterns of geographical

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distribution and species richness of the southern African tree flora, we examine hypotheses which have been advanced in explanations for the distribution of trees in other regions (Monk, 1967), or other major groups of plants or animals (Fischer, 1960; Williams, 1964; Pianka, 1966; Recher, 1971; Werger, 1978; McCoy and Connor, 1980). More particularly, we examine the following predictions: there should be an increase in species richness with a decrease in geographical latitude; and, there should be a decrease in species richness with an increase in aridity.

#### MATERIAL AND METHODS

The main data base was assembled from 1 362 distributional maps for indigenous tree species in Coates Palgrave (1977). These maps summarize records lodged at herbaria in southern Africa and represent the localities of occurrence enclosed within a continuous boundary, and cover all political states south of S 15°, except for Mozambique for which only the area south of the Zambezi River was included. Further, these maps do not represent an atlas of tree species but an aid to identification; however, they remain the only available source on tree distributions. With the concomitant increase in data base accuracy and resolution together with the refinement of analytical techniques (to increase data handling capabilities) the phytogeography for southern African trees based on quantified approaches will improve. A grid of 70 quadrats (Fig. 1) was used to transform each map into a numerical form; each quadrat being scored for each species according to a 1–10 scale, with each of the 10 numerals accounting for 10 % of the area of each quadrat and thus results in a 95 340 cell matrix.

Cluster analysis (Field and McFarlane, 1968; Anderberg, 1973) and multi-dimensional scaling (Kruskal, 1964) were used to identify groups of quadrats with similar species compositions. These two methods allow relatively objective and repeatable determination of potential patterns of sample grouping, based on all measured attributes (i.e. species) considered simultaneously and equally (Sneath and Sokal, 1973; Clifford and Stephenson, 1975). Information statistic tests (Field, 1969) were used to determine the species which characterize ( $P < 0.01$ ) the groups of quadrats. The distribution of the most characteristic species was used in conjunction with the cluster analysis and ordination to produce a final pattern of tree assemblages. The species richness for each quadrat was subjected to a contouring programme (S. G. P. Diederiks, 1979) which fitted a surface, by a least squares polynomial analysis, to the data for visual representation.

Correlation and stepwise multiple linear regression analyses (Sokal and Rohlf, 1969; Allen, 1973) were used to determine possible relationships between species richness (the dependent variable) and ten measures of the en-

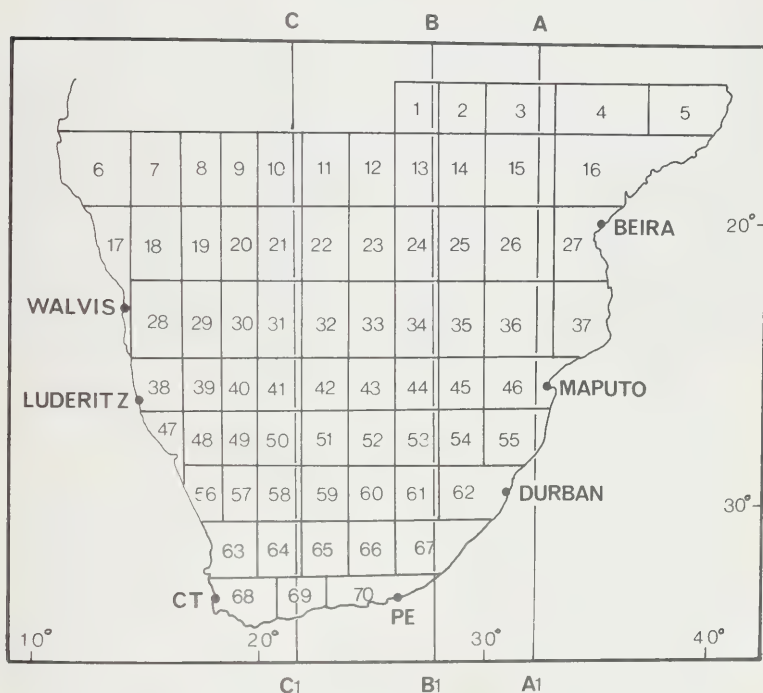


FIG. 1

The grid of quadrats (numbered 1-70) used in an analysis of the distribution of tree species in southern Africa. The lines A-A1, B-B1 and C-C1 represent transects (see Fig. 6).

vironment (the independent variables): mean annual solar radiation (ANN-RAD); mean annual temperature (XTEMP); mean annual temperature range (TRANGE); January maximum temperature (TMAX); July minimum temperature (TMIN); mean annual rainfall (XRF); range in annual rainfall (RRANGE); altitudinal range (ARANGE); water surplus (WPLUS); and, actual evaporation (AE). These environmental data were taken from Talbot and Talbot (1960); Jackson (1961); Thornthwaite (1962); Clark (1967); and Schulze and McGee (1978).

## RESULTS

A line drawn at the 20% similarity level across the dendrogram showing clusters of species assemblages (Fig. 2) separates six groups or provinces

(A–F), which were also distinct in multi-dimensional scaling (Fig. 3). Within three of these provinces, smaller clusters were identified between the 35 and 45 % similarity levels, and were designated as subprovinces (Figs. 2 & 3). The geographical boundaries of these areas are shown in Figure 4a. Figure 5 shows that species richness is relatively high in the eastern portion of the subcontinent, but there are few, if any, signs of an increase in species richness with a decrease in latitude (Fig. 6). Species richness is correlated positively and most strongly with mean annual rainfall (Fig. 7, Table 1). The second most strongly, though negatively, correlated environmental variable is mean annual solar radiation (Fig. 8, Table 1). The environmental variable with the second highest coefficient of determination is altitudinal range (Fig. 9, Table 1). Table 2 summarizes the results of the stepwise multiple regression analysis.

## DISCUSSION

### *Phytochorology*

Werger's (1978) phytochorology for southern Africa includes a Karoo-Namib region north of a Capensis subkingdom. He recognizes five domains within the Karoo-Namib region: Namib, Namaqualand, South Kalahari, Western Cape, and Karoo. In our subdivision of southern Africa, the Karoo province stretches much farther eastwards, but not as far northwards. Moreover, our Kalahari province is more distinctive, our belt along the Indian Ocean extends much farther inland, and Werger's (Fig. 4b) Namib region is split into northern and southern parts. There is also a minor difference, in that our Afro-montane Forest and Alpine Veld is more continuous than Werger's (Fig. 4b) and more closely approximates White's (1978) distribution of the division (Fig. 4c). White's Afro-montane archipelago includes two major assemblages for southern Africa, the Chimanimani in the north (comparable to our Zambezian Montane Forest) and the Drakensberg in the south (comparable to our Afro-montane Forest and Alpine Veld). However, unlike White's scheme, our eastern Karoo stretches to the western boundary of the Afro-montane Forest and Alpine Veld.

Other differences between White's scheme and ours are that he seems to have drawn little distinction between the Namib and the Karoo and in accordance with most other phytogeographers he does not recognize a separate Kalahari area.

Our phytochorological arrangement deviates from all other schemes in that we do not identify a strikingly distinct Capensis area; instead, we include a Capensis element at a second-order subprovince level. The main reason for this discrepancy rests in the selection of trees only for this study,

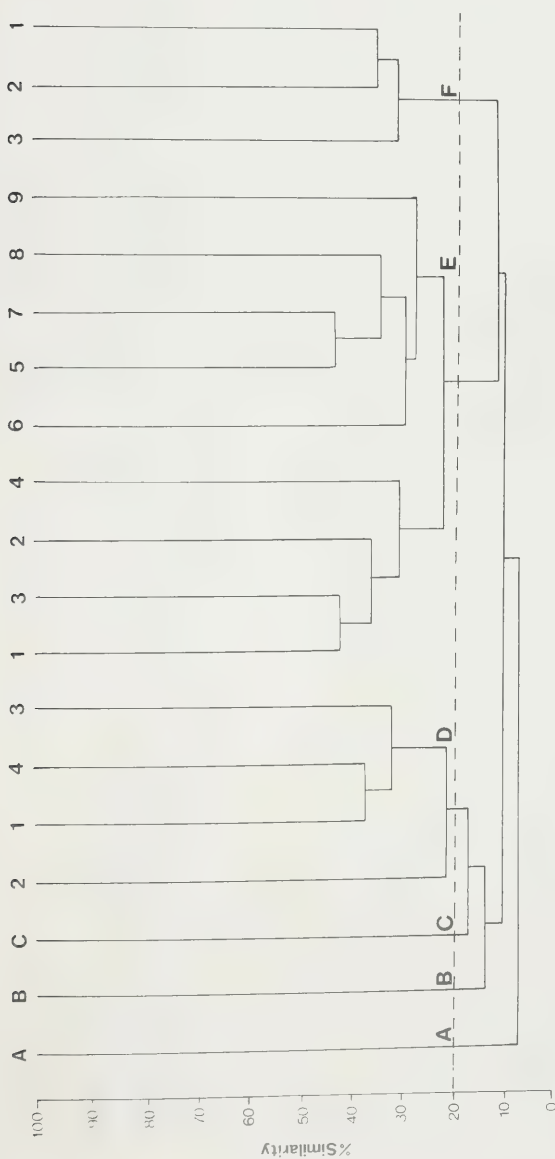


Fig. 2  
The result of cluster analysis of 70 quadrats according to their tree species in southern Africa.

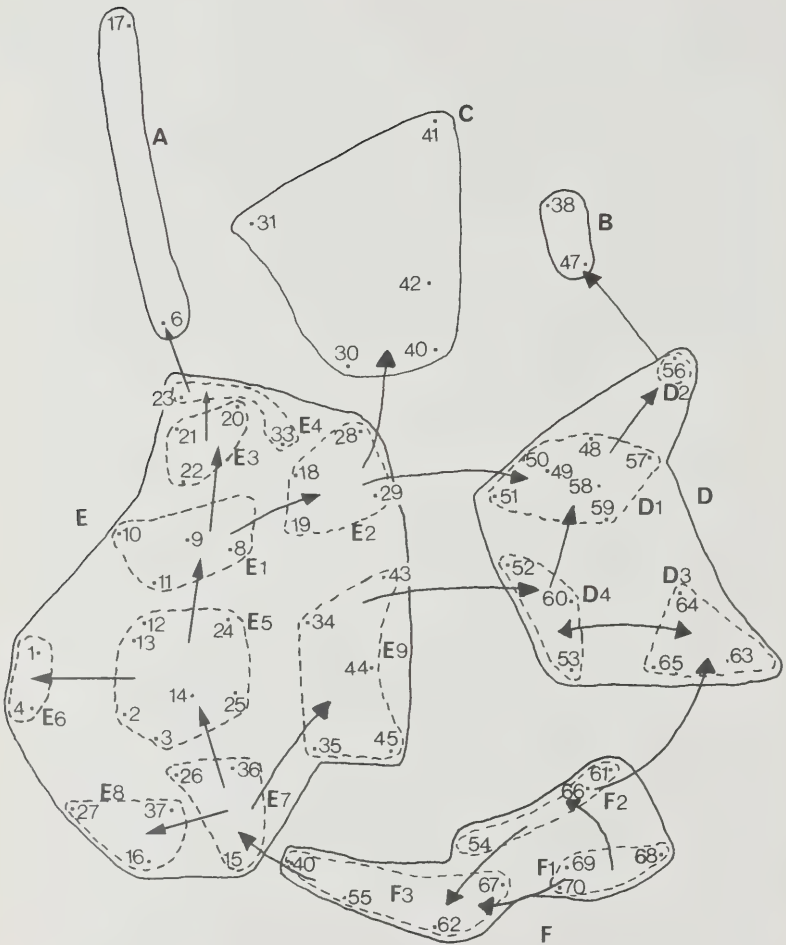


FIG. 3

The result of multi-dimensional scaling of 70 quadrats according to their tree species in southern Africa. The arrows indicate possible routes of species radiation.



TABLE 1

Correlation coefficient matrix of tree species richness and 10 environmental variables in southern Africa. SR = species richness, ANNRAID = annual solar radiation, XTEMP = mean annual temperature, TRANGE = annual temperature range, TMAX = maximum January temperature, TMIN = minimum July temperature, XRF = mean annual rainfall, RRANGE = annual range of rainfall, ARANGE = altitude range, WPLUS = water surplus, and AE = actual evaporation.

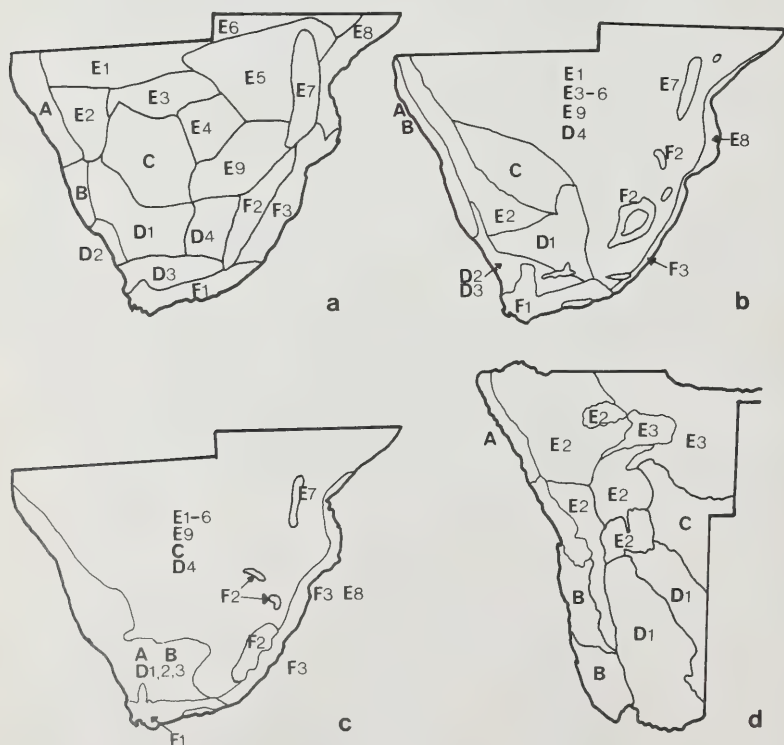
NAME	SR	ANNRAID	XTEMP	TRANGE	TMAX	TMIN	XRF	RRANGE	ARANGE	WPLUS	AE
SR											
ANNRAID	-0.622 *										
XTEMP	0.211	0.121									
TRANGE	-0.525	0.555	-0.106								
TMAX	0.143	0.342	0.484	0.551							
TMIN	0.273	-0.262	0.471	-0.756	-0.174						
XRF	0.641	-0.605	0.223	-0.400	-0.079	0.195					
RRANGE	0.527	-0.564	0.043	-0.499	-0.087	0.291	0.626				
ARANGE	0.492	-0.575	-0.456	-0.451	-0.560	0.038	0.301	0.403			
WPLUS	0.469	-0.459	0.247	-0.481	0.078	0.380	0.565	0.460	0.255		
AE	0.576	-0.531	0.177	-0.306	-0.136	0.107	0.942	0.552	0.250	0.290	

\* Critical values of  $r$  for significance levels are:  $r = 0.235$ ;  $p = 0.05$ ;  $r = 0.306$ ;  $p = 0.01$ .

TABLE 2

Results of stepwise regression analysis between quadrat tree species numbers and the environmental variables listed in Table 1 for southern Africa. XRF = mean annual rainfall, ARANGE = altitude range, XTEMP = mean annual temperature, and ANNRAD = mean annual radiation.

Variable	Coefficient of determination ( $R^2$ )	Regression Coefficient (Z)
XRF	0,41	0,41
ARANGE	0,50	0,07
XTEMP	0,59	22,96
ANNRAD	0,62	-2,77



thereby excluding the majority of the Capensis flora. However, there is also increasing evidence in favour of elements of the Capensis flora having affinities with the Alpine Veld of Lesotho (Killick, 1978).

The relatively large area of the Karoo province in our scheme may also be due to the selection of trees only. Trees are relatively sensitive to arid conditions, and all relatively dry areas may have been included in the Karoo simply because their trees are of a Karoo type, whereas the annual vegetation belongs to a different biotype. Although our Karoo, Kalahari and two Namib areas in South West Africa/Namibia do not conform with other generalized schemes (Fig. 4b), they do agree fairly closely with the vegetation types in Giess's (1970) map of the territory (Fig. 4d).

### *Biogeographical affinities*

Our Central and South Namib (B) is the most distinct province, in that its closest point to its nearest neighbour is the farthest for any of the provinces (Fig. 3). Its closest neighbour, and therefore its closest affinities, could be with the Succulent West Coast Karoo (D2). Our Northern Namib (A) also has no very close affinities; the closest being with the Eastern Botswana Mopane subprovince (E4). It is surprising that the two provinces (Northern Namib and Central and South Namib) are quite so dissimilar, when geographically they lie adjacent to each other. The Kalahari (C) has strongest affinities with the Eastern Botswana Mopane (E4) and Thorn Tree Bushveld

FIG. 4

The proposed phytochorology compared to published phytochorologies. (a) Provinces (A-F) and subprovinces (1-9) found by cluster analysis and multi-dimensional scaling of the distribution of 1 362 tree species in southern Africa. The boundaries of the provinces and subprovinces are based on the individual distribution patterns of the 10 most characteristic species (see Appendix 1) being super-imposed on one another, and where intersections of 80 % or more occurred the intersection areas were enclosed in a continuous boundary. (b), (c) and (d) are redrawn maps of Werger's phytochorology (1976), White's phytochorology (1965, 1971), and Giess's phytochorology for South-West Africa/Namibia (1970) respectively. Each of these maps have our corresponding regions' names inserted to show the degree of compatibility. Names of the provinces and subprovinces:

A = Northern Namib, B = Central and South Namib, C = Kalahari, D = Karoo, E = Zambeziaca, F = Afro-montane and Coastal Forest, D1 = Arid Karoo, D2 = Succulent West Coast Karoo, D3 = Lower Mixed Veld Karoo, D4 = False Upper Karoo with Mixed Grassland, E1 = Combretum Tree Savanna and Woodland, E2 = Thorn Tree Bushveld, E3 = Mixed Acacia Bushveld, E4 = Eastern Botswana Mopaneveld, E5 = Matabele Tree Savanna and Woodland, E6 = Zambezian Mixed Tree Savanna and Forest, E7 = Zambezian Montane Forest, E8 = Mozambique Coastal Woodland and Savanna, E9 = Transvaal Mixed Bushveld, F1 = Capensis Montane Forest and Fynbos, F2 = Afro-montane Forest and Alpine Veld, F3 = Coastal Forest and Thornveld.

(E2) subprovinces, respectively. The Karoo (D) and Zambeziaca (E) provinces tend to be closest together at the Thorn Tree Bushveld (E2) and Arid Karoo (D1) subprovinces. The Afro-montane and Coastal Forest (F) province seems to have greatest affinities with the Zambeziaca (E) province, the most similar subprovinces between them being the Zambezian Montane Forest (E7) and the Coastal Forest and Thornveld (F3). This might be expected, since these areas experience similar temperature and rainfall regimes.

Southern Africa probably was covered by savanna and Cape sclerophyllous vegetation during the early Neogene (Axelrod and Raven, 1978). Alternating drought and wet periods are believed to have promoted enhanced plant speciation, in that during moist periods the sclerophyllous vegetation expanded into the present-day Karoo and speciated rapidly, whereas a coastward retraction occurred during dry conditions, leaving relict stands in the Karoo (Axelrod and Raven, 1978). Thus, relatively close affinities between the Karoo and Capensis might be expected. However, our Capensis Montane Forest and Fynbos (F1) subprovince is closest to the coastal forest and Thornveld (F3), and the whole of the Afro-montane and coastal Forest (F) province has affinities with a savanna, rather than a Karoo system (Fig. 3). Perhaps the onset of a dry climate and the forming of a Karoo system in its present position selectively excluded many trees, as opposed to relatively short-lived plants better able to escape the extremes of droughts. On this basis, it seems that our Karoo (D) province, with its dissimilar dominant species, represents a combination of the more xerophytic elements of the postulated former savanna and Cape sclerophyllous vegetation types.

During the Miocene the climate progressively became drier, restricting forest, while new vegetation forms, such as thorn scrub and grassland developed and savanna spread. Figure 3 shows that the Transvaal Mixed Bushveld (E9) subprovince has closer affinities with the Thorn Tree Bushveld (E2) than with its neighbouring Eastern Botswana Mopaneveld (E4). It seems likely that with increasing aridity the formerly continuous savanna between these two areas (E2 and E9) split, with the development of the Kalahari (C) in between and within the very dry interior basin.

A possible explanation of the dissimilarity between the adjacent Northern Namib (A) and Central South Namib (B) provinces might be that while the Northern Namib developed from the drier fringes of a tropical savanna, the Central South Namib developed at a later stage from the drier periphery of a then well-established Karoo system.

### *Species richness and environmental variables*

Rainfall patterns for southern Africa demonstrate that the subcontinent is almost bisected by the 400 mm isohyet, with the eastern half considerably

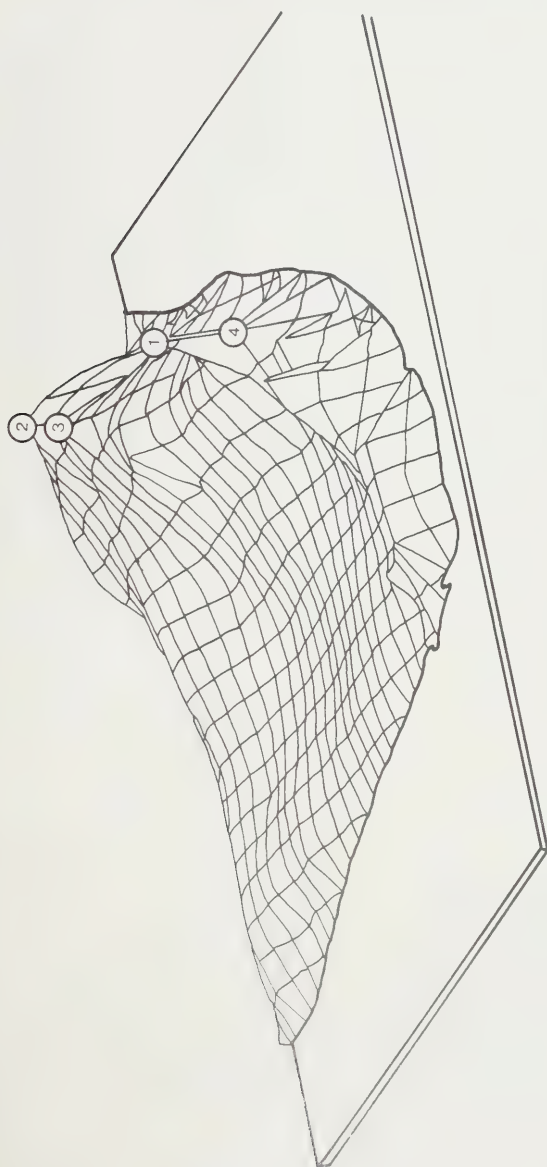


FIG. 5  
Three-dimensional representation of the distribution of tree species richness in southern Africa (see Appendix 2). 1 = Komatipoort-Lebombo mountains (607 spp.), 2 = Vila Gouveia-Gorongosa (570 spp.), 3 = Haroni-Lusitu confluence (562 spp.), 4 = Zululand (554 spp.) are place names of areas with highest species richness.



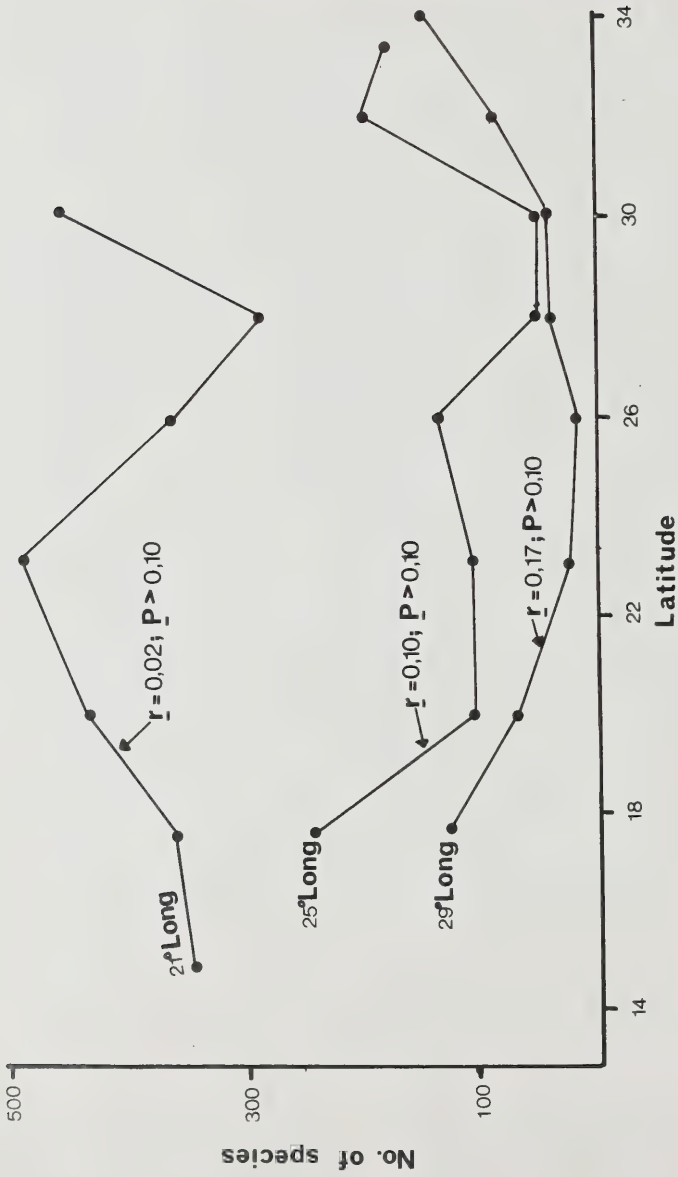


FIG. 6  
Species richness of trees along three transects A-A1, B-B1 and C-C1 (see Fig. 1) in relation to latitude in southern Africa.

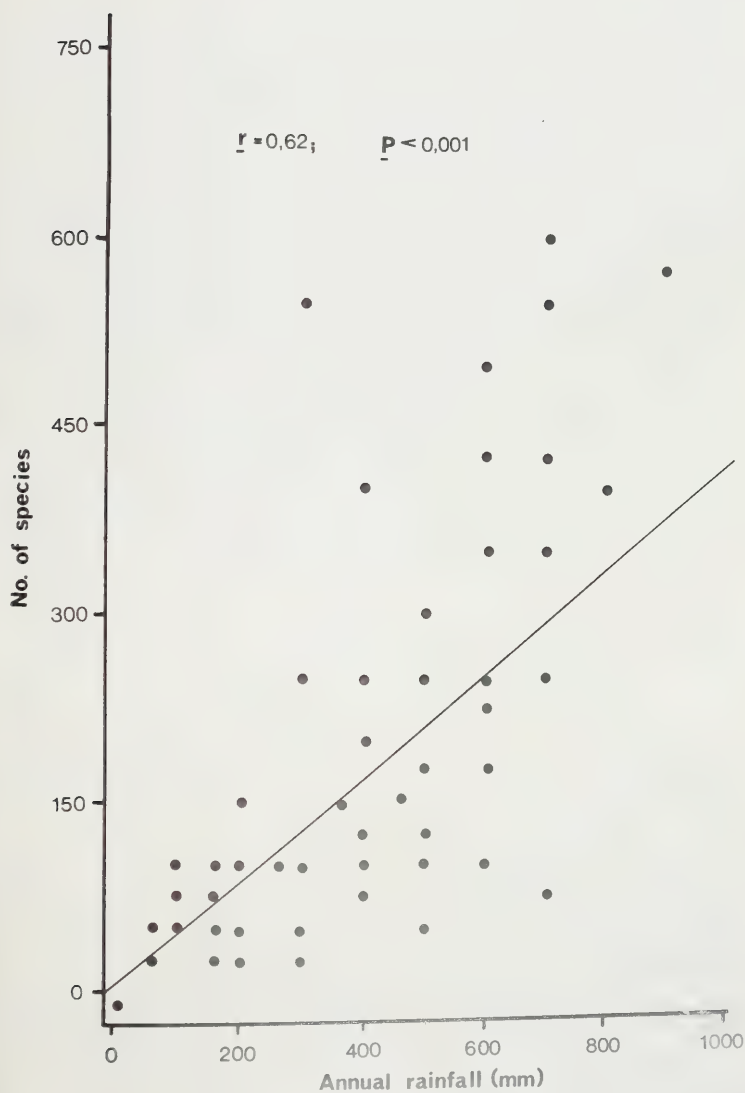


FIG. 7  
Relationship between species richness of trees and mean annual rainfall in southern Africa.

moister than the western half (Jackson and Tyson, 1971). In general, tree species richness increases with increases in precipitation (Fig. 7), but it is probably more meaningful biologically to relate tree species richness to the extent of a positive difference between precipitation and water losses of the plants. Thus, a surprising result of our analyses is the low correlation between water surplus (WPLUS) and species richness (Table 1).

The intercorrelation between incoming solar radiation, temperature and precipitation, helps to explain why altitude range (ARANGE) has the second highest coefficient of determination in the multiple linear regression analysis (Table 1). In the stepwise regression analysis, only environmental variables which are not significantly correlated with those already in the regression equation can contribute to the regression (Allen, 1973). Thus, correlation and stepwise regression analysis are complementary statistical approaches (Crowe, 1979).

The most significant feature to emerge from the multiple characterization of each of our phytochorological provinces and subprovinces by environmental variables is that, areas with complex environments are not necessarily supportive of relatively high species richness. For instance, the Northern Namib province has great variability in temperature, rainfall and altitude, but the general aridity of the area apparently limits tree diversity, whereas other areas with less environmental diversity but higher rainfall support more species of trees.

Tropical biotas are thought to evolve and diversify relatively rapidly, because the tropics are less subject to widespread catastrophic events (e.g. glaciation) than temperate regions. On the other hand, the more heterogeneous and complex the physical environment becomes the more complex, and hence diverse, the biota becomes. The tropics are thought to be relatively heterogeneous and, therefore, to support more species than temperate regions. Thus, in essence, there are two lines of thought for explaining enhanced species richness in the tropics; and, they can be termed the "stability" and "heterogeneity" hypotheses, respectively.

If most of the variation in the species richness of the southern African tree flora could be linked with a combination of significant environmental variables, it could indicate subjectively a favouring of the "heterogeneity" hypothesis. For this to operate, the multiple regression analysis should have a high  $R^2$  value (e.g. 0.85 or more). If, on the other hand, the variation in tree species richness is not only a function of present-day environmental variation, we would expect a much lower  $R^2$  value (e.g. less than 0.66). We would interpret such a result to be consistent with a "stability" hypotheses, especially if the  $R^2$  value was less than 0.50. Since the  $R^2$  in the present study is 0.63, the most likely hypothesis is a mixed one. In other words, both environmental heterogeneity and stability have contributed to the observed

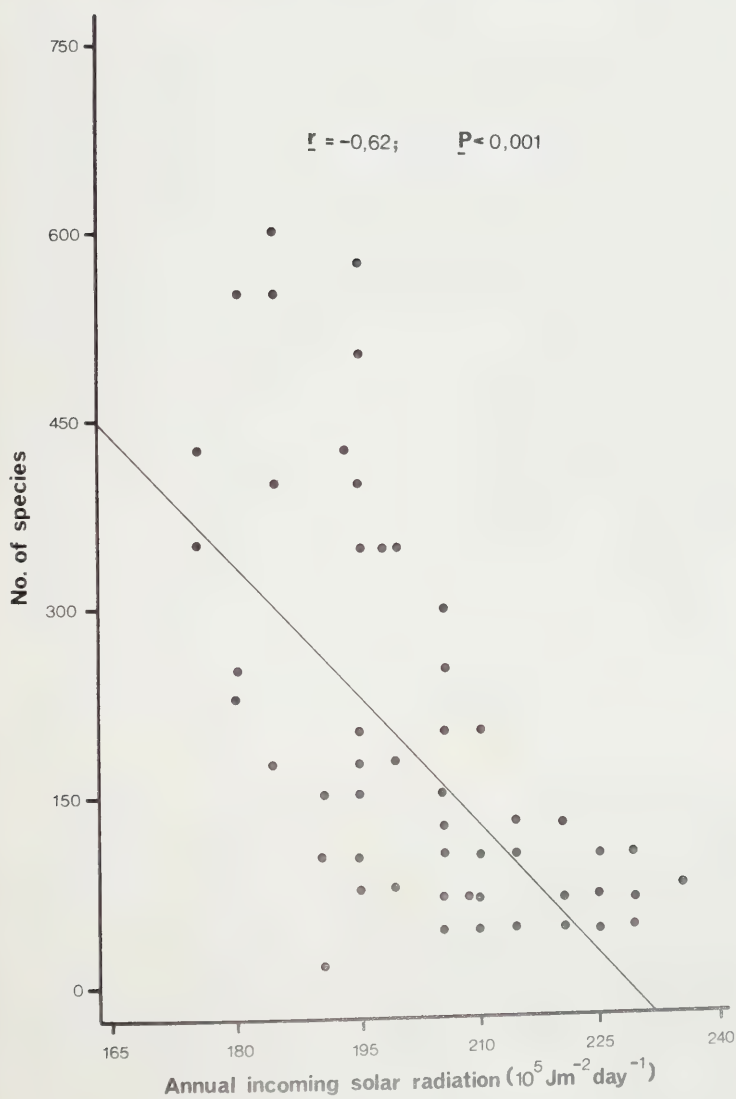


FIG. 8  
Relationship between species richness of trees and mean annual solar radiation in southern Africa.

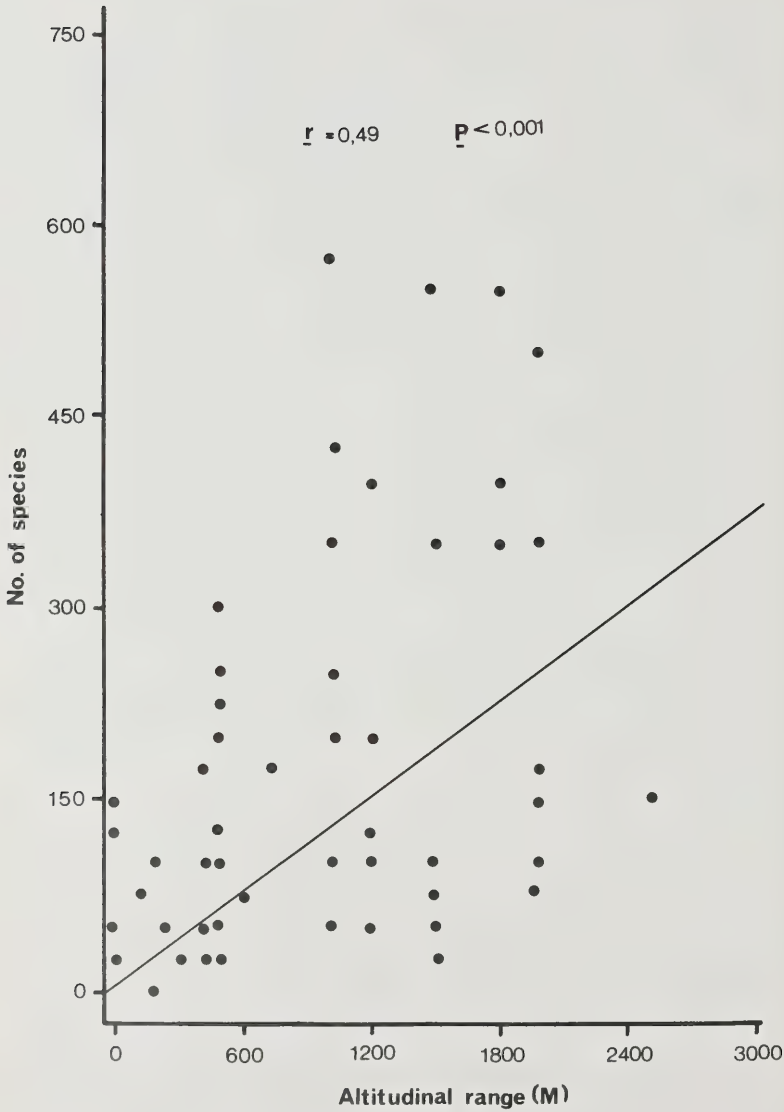


FIG. 9  
Relationship between species richness of trees and altitudinal range in southern Africa.



patterns of diversity. Moreover, those quadrats which have far more species than their present-day environmental heterogeneity would predict (e.g. quadrats 15, 26, 35 and 55; Figs 1 & 5 and Appendix 2) are, by inference, the most likely centres of stability. We predict that these centres of stability could have been "refugia" sensu Simpson and Haffer (1978).

Accepting that the subcontinent has been changing from a wet regime to a drier one, it is logical that the last areas to be directly affected would be protected gorges on the windward side of mountains. It is only in these areas that sufficient moisture can be retained for the support of past, "super-saturated", climax communities of trees, and therefore have an observed high species richness. Moreover, these communities are located in areas of high habitat diversity and thus would tend to conform to the "heterogeneity" hypothesis as well.

All four areas of exceptionally high species richness (Fig. 5) are characterized by a high diversity of habitat types. The Komatipoort area includes the moist, windward side of the Lebombo mountains and the southern Mozambique coastal plain, as well as the drier leeward side of the Lebombo range. The Vila Gouveia area includes the Gorongosa and Amatonga forests in the east, and well developed gallery forests along the streams of the Manica platform. East of Inyanga there are large Afro-montane forests and to the west a dominant moist deciduous woodland (*Brachystegia*) prevails. The Chipinga-Espungabera is the site of the Haroni-Lusita confluence and the steep descent of the Chimanimani mountains. It is here that high-altitude montane and high and low-altitude deciduous and riparian forests exist, as well as dry gallery forest along the Sabi river. Such a wide range of forest types within relatively small areas can be expected to yield high levels of richness in tree species.

## CONCLUSIONS

This report shows that meaningful phytochorological results can be achieved through study of the distribution of tree species in southern Africa, using modern quantitative methods. The derived phytochorology has a great deal of compatibility with schemes based on subjective decisions and qualitative information. We propose a two-tier classification for assemblages of tree species, and suggest that some of the relationships between assemblages are the result of changes in vegetation patterns in the past. Evidence for tree species richness increasing with decreasing geographical latitude is not encouraging, whereas an hypothesis for an expected decrease in species richness with increasing aridity is acceptable. Apparently the balance between water input, in the form of rainfall, and water losses, linked with high solar radiation and temperature levels, is a critical factor determining the number of tree species in any given area. The sum of the environmental variables

studied cannot, however, adequately explain species richness variability and, therefore, other environmental factors that are not readily quantifiable (e.g., wind conditions), and/or historical factors, must be operating.

The results of our study apparently confirm Strahler's (1978) assertion that, "species groups tended not to be just groups with similar environmental preferences, but distinctive associations as well, with significance beyond their relationships to a particular site factor".

#### ACKNOWLEDGEMENTS

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## APPENDIX 1

The 10 most characteristic ( $P < 0.01$ ) tree species for each province and subprovince in southern Africa according to the information statistic test. Where there are fewer than 10 species for a province or a subprovince all the characteristic species are included.

## Province A, Northern Namib

Species	2ΔI Value
<i>Commiphora wildii</i> .....	90.00
<i>Welwitschia mirabilis</i> .....	70.49
<i>Commiphora tenuipetiolata</i> .....	47.19
<i>Commiphora multijuga</i> .....	37.10
<i>Boscia tomentosa</i> .....	35.55

## Province A, Northern Namib

Species	2ΔI Value
<i>Commiphora anacardiifolia</i> . . . . .	29,51
<i>Commiphora kraeuseliana</i> . . . . .	22,99
<i>Entandrophragma spicatum</i> . . . . .	22,99
<i>Euphorbia eduardoi</i> . . . . .	21,33
<i>Combretum wattii</i> . . . . .	20,44

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## Province B, Central and South Namib

Species	2ΔI Value
<i>Parkinsonia africana</i> . . . . .	55,71
<i>Ozoroa concolor</i> . . . . .	21,98
<i>Cyphostemma bainesii</i> . . . . .	15,73
<i>Tammarix usneoides</i> . . . . .	7,27
<i>Rhus viminalis</i> . . . . .	7,24
<i>Rauvolfia caffra</i> . . . . .	5,93
<i>Pterocarpus rotundifolius</i> . . . . .	5,60
<i>Commiphora capensis</i> . . . . .	4,68
<i>Commiphora saxicola</i> . . . . .	4,68

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## Province C, Kalahari

Species	2ΔI Value
<i>Ehretia rigida</i> . . . . .	56,35
<i>Rhigozum brevispinosum</i> . . . . .	27,82
<i>Ozoroa paniculosa</i> . . . . .	17,61
<i>Combretum collinum</i> . . . . .	15,14
<i>Acacia haematoxylon</i> . . . . .	12,15
<i>Grewia flava</i> . . . . .	10,20
<i>Catophractes alexandri</i> . . . . .	8,95
<i>Acacia nebrownii</i> . . . . .	5,49

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## Province D, Karoo

Species	2ΔI Value
<i>Nymanina capensis</i> . . . . .	192,50
<i>Rhus viminalis</i> . . . . .	163,10
<i>Salix mucronata</i> . . . . .	153,51
<i>Rhus undulata</i> . . . . .	148,17
<i>Ozoroa dispar</i> . . . . .	147,88
<i>Salsola aphylla</i> . . . . .	124,04
<i>Maytenus linearis</i> . . . . .	111,75
<i>Acacia haematoxylon</i> . . . . .	102,38
<i>Cadaba aphylla</i> . . . . .	91,34
<i>Aloe comosa</i> . . . . .	88,46

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Province E, Zambeziaca

Species	2ΔI Value
<i>Combretum imberbe</i> .....	238,00
<i>Burkea africana</i> .....	235,26
<i>Combretum hereroense</i> .....	219,51
<i>Peltophorum africanum</i> .....	208,02
<i>Securinea virosa</i> .....	202,94
<i>Dombeya rotundifolia</i> .....	195,59
<i>Commiphora africana</i> .....	191,35
<i>Combretum apiculatum</i> .....	184,09
<i>Piliostigma thonningii</i> .....	175,83
<i>Adansonia digitata</i> .....	171,90

Province F, Afro-montane and Coastal Forest

Species	2ΔI Value
<i>Rhus erosa</i> .....	256,88
<i>Clusia pulchella</i> .....	249,77
<i>Scolopia mundii</i> .....	243,26
<i>Scutia myrtina</i> .....	228,07
<i>Cassine peragua</i> .....	223,65
<i>Galpinia transvaalica</i> .....	214,74
<i>Rapanea melanophloeos</i> .....	214,56
<i>Maytenus acuminata</i> .....	210,59
<i>Chrysanthemoides monilifera</i> .....	206,35
<i>Burchellia bubalina</i> .....	204,81

Subprovince D1, Arid Karoo

Species	2ΔI Value
<i>Acacia haematoxylon</i> .....	64,03
<i>Boscia foetida</i> .....	53,32
<i>Aloe comosa</i> .....	35,33
<i>Adenolobus garipensis</i> .....	23,29
<i>Ozoroa namaensis</i> .....	22,63
<i>Acacia erioloba</i> .....	22,35
<i>Rhigozum brevispinosum</i> .....	21,32
<i>Salsola aphylla</i> .....	20,81
<i>Nymania capensis</i> .....	20,07
<i>Aloe littoralis</i> .....	18,85

Subprovince D2, Succulent West Coast Karoo

Species	2ΔI Value
<i>Aloe ramosissima</i> .....	45,33
<i>Ozoroa concolor</i> .....	28,33
<i>Euclea racemosa</i> .....	21,90
<i>Dideltia spinosa</i> .....	20,22
<i>Maerua gilgii</i> .....	19,90



## Subprovince D2, Succulent West Coast Karoo

Species	2ΔI Value
<i>Euphorbia guerichiana</i> .....	18,09
<i>Ozoroa crassinervia</i> .....	16,89
<i>Aloe pillansii</i> .....	15,27
<i>Pachypodium namaquanum</i> .....	14,04
<i>Cotyledon paniculata</i> .....	8,03

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## Subprovince D3, Lower Mixed Veld Karoo

Species	2ΔI Value
<i>Chrysanthemoides monilifera</i> .....	41,69
<i>Dodonaea viscosa</i> .....	38,62
<i>Buddleja glomerata</i> .....	38,62
<i>Protea arborea</i> .....	32,18
<i>Phytica oleifolia</i> .....	32,18
<i>Phytica villosa</i> .....	32,18
<i>Rhus tomentosa</i> .....	28,97
<i>Hartogia schinoides</i> .....	28,97
<i>Kiggelaria africana</i> .....	27,74
<i>Diospyros glabra</i> .....	25,75

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## Subprovince D4, False Upper Karoo with Mixed Grassland

Species	2ΔI Value
<i>Rhus leptodictya</i> .....	48,65
<i>Euclea crispa</i> .....	48,63
<i>Ilex mitis</i> .....	47,33
<i>Ficus soldanella</i> .....	46,87
<i>Protea caffra</i> .....	46,87
<i>Celtis africana</i> .....	44,95
<i>Cussonia paniculata</i> .....	43,52
<i>Carissa bispinosa</i> .....	43,52
<i>Diospyros whyteana</i> .....	41,28
<i>Rhus pyroides</i> .....	40,27

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## Subprovince E1, Combretum Tree Savanna and Woodland

Species	2ΔI Value
<i>Grewia schinzii</i> .....	96,79
<i>Combretum engleri</i> .....	65,24
<i>Ozoroa longipes</i> .....	61,35
<i>Combretum psidioides</i> .....	49,96
<i>Combretum celastroides</i> .....	46,77
<i>Steganotaenia araliacea</i> .....	43,23
<i>Pachypodium lealii</i> .....	42,72
<i>Bridelia tenuifolia</i> .....	38,91
<i>Bauhinia urbaniana</i> .....	35,02
<i>Entandrophragma spicatum</i> .....	35,02

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## Subprovince E2, Thorn Tree Bushveld

Species	2ΔI Value
<i>Ozoroa crassinervia</i> .....	110,57
<i>Moringa ovalifolia</i> .....	95,43
<i>Euclea pseudebenus</i> .....	90,20
<i>Cyphostemma currorii</i> .....	83,82
<i>Ficus cordata</i> .....	77,73
<i>Boscia foetida</i> .....	77,73
<i>Ficus ilicina</i> .....	74,08
<i>Montinia caryophyllacea</i> .....	73,74
<i>Vernonia cinerascens</i> .....	72,98
<i>Commiphora tenuipetiolata</i> .....	69,92

## Subprovince E3, Acacia Bushveld

Species	2ΔI Value
<i>Lonchocarpus nelsii</i> .....	26,09
<i>Acacia fleckii</i> .....	24,98
<i>Grewia retinervis</i> .....	15,99
<i>Combretum collinum</i> .....	15,52
<i>Catophractes alexandri</i> .....	13,28
<i>Commiphora angolensis</i> .....	11,49
<i>Rhus tenuinervis</i> .....	9,98
<i>Commiphora africana</i> .....	7,28
<i>Bauhinia petersiana</i> .....	6,84
<i>Hibiscus diversifolius</i> .....	4,91

## Subprovince E4, Eastern Botswana Mopane

Species	2ΔI Value
<i>Colophospermum mopane</i> .....	9,77
<i>Catophractes alexandri</i> .....	8,45
<i>Albizia harveyi</i> .....	5,82
<i>Grewia tenax</i> .....	4,78
<i>Hyphaene benguellensis</i> .....	4,53
<i>Acacia nebrownii</i> .....	4,15

## Subprovince E5, Matabele Savanna and Woodland

Species	2ΔI Value
<i>Vepris zambesiaca</i> .....	119,81
<i>Cassia singueana</i> .....	111,33
<i>Euphorbia matabelensis</i> .....	108,60
<i>Boscia angustifolia</i> .....	99,85
<i>Azanza garckeana</i> .....	97,72
<i>Combretum elaeagnoides</i> .....	94,70
<i>Commiphora mossambicensis</i> .....	92,63
<i>Elephantorrhiza goetzei</i> .....	85,47
<i>Dalbergia melanoxylon</i> .....	76,65
<i>Pterocarpus rotundifolius</i> .....	76,28

## Subprovince E6, Zambezan Mixed Tree Savanna and Forest

Species	2ΔI Value
<i>Rhodognaphalon schumannianum</i> .....	22,89
<i>Triplochiton zambesiacus</i> .....	20,48
<i>Schrebera trichoclada</i> .....	14,96
<i>Leptactina hexamera</i> .....	11,44
<i>Diospyros squarrosa</i> .....	10,60
<i>Tamarindus indica</i> .....	10,57
<i>Monotes engleri</i> .....	10,10
<i>Uapaca nitida</i> .....	9,52
<i>Cola mossambicensis</i> .....	9,43
<i>Allophylus africanus</i> .....	8,37

## Subprovince E7, Zambezan Montane Forest

Species	2ΔI Value
<i>Cassia petersiana</i> .....	66,12
<i>Acacia xanthophloea</i> .....	61,50
<i>Androstachys johnsonii</i> .....	58,20
<i>Stadmania oppositifolia</i> .....	56,84
<i>Breonadia microcephala</i> .....	53,73
<i>Strychnos mellodora</i> .....	49,13
<i>Xeromphis rudis</i> .....	47,98
<i>Rinorea elliptica</i> .....	47,34
<i>Trichilia emetica</i> .....	46,71
<i>Thilachium africanum</i> .....	46,60

## Subprovince E8, Mozambique Coastal Woodland and Savanna

Species	2ΔI Value
<i>Casearia gladiiformis</i> .....	85,22
<i>Enterospermum littorale</i> .....	78,62
<i>Coffea racemosa</i> .....	69,86
<i>Diospyros rotundifolia</i> .....	68,78
<i>Drypetes natalensis</i> .....	66,09
<i>Pseudobersama mossambicensis</i> .....	63,87
<i>Tarenna junodii</i> .....	63,79
<i>Ochna natalita</i> .....	60,50
<i>Sonneratia alba</i> .....	58,96
<i>Avicennia marina</i> .....	58,96
<i>Barringtonia racemosa</i> .....	58,96

## Subprovince E9, Transvaal Mixed Bushveld

Species	2ΔI Value
<i>Buddleja saligna</i> .....	115,33
<i>Aloe marlothii</i> .....	114,70

## Subprovince E9, Transvaal Mixed Bushveld

Species	2ΔI Value
<i>Acacia caffra</i> .....	112,42
<i>Commiphora neglecta</i> .....	106,17
<i>Solanum giganteum</i> .....	100,84
<i>Berchemia zeyheri</i> .....	100,35
<i>Nuxia congesta</i> .....	92,59
<i>Canthium suberosum</i> .....	89,51
<i>Cussonia paniculata</i> .....	87,39
<i>Protea caffra</i> .....	85,62

## Subprovince F1, Capensis Montane Forest and Fynbos

Species	2ΔI Value
<i>Rhus incisa</i> .....	72,23
<i>Atalaya capensis</i> .....	72,23
<i>Cassine parvifolia</i> .....	67,42
<i>Freylinia lanceolata</i> .....	65,01
<i>Lachnostylis hirta</i> .....	62,60
<i>Hartogia schinoides</i> .....	58,70
<i>Maytenus oleoides</i> .....	57,79
<i>Protea arborea</i> .....	57,79
<i>Euclea racemosa</i> .....	50,10
<i>Olea exasperata</i> .....	49,85

## Subprovince F2, Afro-montane Forest and Alpine Veld

Species	2ΔI Value
<i>Rhus transvaalensis</i> .....	73,46
<i>Rhus erosa</i> .....	37,57
<i>Calpurnia robinoides</i> .....	28,89
<i>Rhus montana</i> .....	21,67
<i>Protea caffra</i> .....	19,26
<i>Euphorbia curvirama</i> .....	12,04
<i>Euclea coriacea</i> .....	11,97
<i>Leucosidea sericea</i> .....	9,15
<i>Cussonia paniculata</i> .....	8,90
<i>Erica caffrorum</i> .....	8,84

## Subprovince F3, Coastal Forest and Thornveld

Species	2ΔI Value
<i>Vitellariopsis marginata</i> .....	58,64
<i>Dombeya cymosa</i> .....	54,97
<i>Turraea floribunda</i> .....	54,97
<i>Euphorbia tirucalli</i> .....	54,24
<i>Brachylaena ilicifolia</i> .....	51,31
<i>Bersama lucens</i> .....	51,31

## Subprovince F3, Coastal Forest and Thornveld

Species	2ΔI Value
<i>Nuxia congesta</i> .....	50,70
<i>Tricalysia capensis</i> .....	48,93
<i>Cussonia sphaerocephala</i> .....	47,64
<i>Diospyros villosa</i> .....	47,64

## APPENDIX 2

The number of tree species in the quadrats shown in Fig. 1.

No.	Spp.	No.	Spp.	No.	Spp.	No.	Spp.	No.	Spp.
1	242	15	570	29	93	43	117	57	59
2	342	16	355	30	46	44	180	58	44
3	409	17	20	31	26	45	349	59	33
4	181	18	112	32	13	46	607	60	51
5	1*	19	109	33	96	47	25	61	95
6	90	20	57	34	209	48	60	62	49
7	142	21	62	35	494	49	53	63	74
8	126	22	103	36	395	50	41	64	65
9	121	23	96	37	233	51	41	65	94
10	113	24	238	38	27	52	55	66	202
11	189	25	434	39	63	53	85	67	359
12	238	26	562	40	31	54	258	68	148
13	295	27	251	41	13	55	554	69	160
14	352	28	95	42	30	56	44	70	187

\* Excluded from the multivariate analysis as most of it fell outside the range of the maps used in Coates Palgrave.



## THE FERN GENUS *ELAPHOGLOSSUM* SCHOTT (FILICALES) IN SOUTH AFRICA

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### ABSTRACT

The morphology, habitat, distribution and ecology of the eight *Elaphoglossum* species which are known to occur within the flora of South Africa area are discussed and a systematic treatment of the taxa is provided.

### UITTREKSEL

#### DIE VARING GESLAG *ELAPHOGLOSSUM* SCHOTT (FILICALES) IN SUID-AFRIKA

Die morfologie, habitat, verspreiding en ekologie van die agt *Elaphoglossum* spesies wat binne die flora van Suid-Afrika area aangetref word, word bespreek. 'n Taksonomiese verhandeling van die betrokke spesies word ook weergegee.

### INTRODUCTION

The classification and the position of the fern genus *Elaphoglossum* in the systematic scheme always was and still remains a subject of much debate. Although no agreement has yet been reached as to where *Elaphoglossum* fits into the overall systematic scheme, most recent pteridologists tend to place *Elaphoglossum* in a position near or between the dryopteroid and davalloid ferns. The position is largely due to cytological evidence.

The generic breakdown and the species concept in *Elaphoglossum* is largely hampered by the uniformity and simplicity in gross morphology of the approximate 400 known species.

The author believes that a system of generic breakdown and a systematic treatment of the genus is not possible unless a better understanding can be formed of the characters on which species discrimination is commonly based. It is for this reason that the characters are individually discussed. The author trusts that it will contribute to and help promote further studies on the characters in other parts of the world which will lead to a better understanding of the genus *Elaphoglossum*.

In the taxonomic part the author has investigated the statements of Schelpe (1969), and has to report three corrections.

- i. *Elaphoglossum conforme* var. *latifolium* Sim is a synonym of *E. angu-*

tatum (Schrad.) Hieron. and not of *E. macropodium* (Fée) Moore. A new lectotype is also proposed for this taxon.

ii. *Acrostichum piloselloides* Presl is not a synonymous with *E. spathulatum* (Bory) Moore. (See p. 515).

iii. *Acrostichum lineare* Fée is a synonym of *E. aubertii* (Desv.) Moore; this is a new observation.

#### HISTORICAL REVIEW

Long before and even after the generic name *Elaphoglossum* was established all ferns which appeared to have acrostichoid soriation were commonly placed in the genus *Acrostichum*. Schott (1834), without description, proposed the name *Elaphoglossum* but it was not formally described until 1841 by J. Smith.

Fée (1845) was the first to prepare a treatment of the genus in his *Histoire des Acrosticées* (Mém. Fam. Foug. 2). The elaphoglossoids were divided into two groups; *Oligolepideae* and *Polylepideae*. Later, in his *Genera Filicum* (Mém. Fam. Foug. 5), Fée (1852) used four primary groups without further subdivision; *Oligolepideae*, *Polylepideae*, *Pilosellae* and *Chromatolepideae*.

The genus name *Elaphoglossum* was not widely accepted but was first used extensively by Moore during the period 1857–1862. His generic breakdown consists of *Oligolepidium*—fronds naked, or with few scales and *Polylepidium*—fronds clothed with numerous scales.

The classic *Monographie des Genus Elaphoglossum* of Christ (1899), stands as the most detailed treatment of the genus, covering 142 species in 32 groups. The primary division was based on venation. In ordo *Stenoneura* the veins run all the way to the margin without thickened vein ends, whereas ordo *Condyloneura* have veins ending short of the margin and they are swollen. The ordos were further subdivided into sections, subsections and divisions.

Bower (1928) on the other hand, referred the genera previously treated as members of the Acrostichae as belonging to different groups of ferns. *Elaphoglossum* belongs to his metaxyoid ferns of which *Metaxya* is the most primitive and *Elaphoglossum* the most advanced genus.

Christensen (1938), gave it its own subfamily, Elaphoglossoideae in the Polypodiaceae-Dryopteroidae. Copeland (1947), placed *Elaphoglossum* as part of the family Aspidiaceae. In the same year, Holttum, because of the dorsiventral scaly rhizome, the free, or nearly free veins, the acrostichoid soriation and spores, placed *Elaphoglossum* in close association with *Lomariopsis*. The subfamily Lomariopsidoideae formed part of his Dennstaedtiaceae. Alston, in 1956, raised the subfamily Lomariopsidoideae to family level.

When dealing with the Malesian species of *Elaphoglossum*, Holttum (1966) proposed a preliminary, very simplified scheme for the subdivision of the genus. This system was entirely based on scale characters.

Pichi Sermilli (1968) created Elaphoglossaceae, an independent family, an entity belonging to the stock of Aspidiales. This was largely due to cytological evidence. He did not recognise it as being closely related to any other family of that order.

His argument is primarily based on differences between *Elaphoglossum* and *Bolbitis* but ignored Holttum's comment that it shows close resemblance to *Lomariopsis*. Frond architecture, frond phylogeny, articulation, venation, sori, spores, gametophyte characters and the habit were the major characters which came under consideration.

Lovis (1977) also placed *Elaphoglossum* in the Lomariopsidaceae, a position between the dryopteroid and davalloid ferns. The dryopteroid relationship was first suggested by Copeland (1947), while the davalloid relationship, especially the Oleandroideae of Lovis, are similar in stele and chromosome number to the Lomariopsidaceae.

Mickel and Atehortúa (1980) revised the system of generic breakdown by subdividing the genus into sections and subsections only. They now recognise 9 sections and 21 subsections, many of which are new.

They also found the spores of *Elaphoglossum* similar to those of *Oleandra* and *Arthropteris* (illustrated by Liew, 1977).

The relationship of *Elaphoglossum* to the other lomariopsidoid ferns remains ambiguous. Holttum (1947) placed it in association with *Lomariopsis* for reasons already stated. Copeland (1947) did not recognise any near relatives, except for two small genera, *Microstaphyla* and *Rhipidopteris*, both of which are now included in *Elaphoglossum* (Mickel, 1980; Mickel & Atehortúa, 1980).

#### DIMORPHISM

Dimorphism is a character commonly used for species discrimination in *Elaphoglossum*. The term, as used here, embraces various features which differ from the sterile to the fertile frond. Frond architecture and orientation, stipe articulation, frond scales and venation patterns show significant dimorphic values and will be discussed below.

#### RHIZOME

In all the relevant taxa the rhizome is creeping. The shape of the rhizome shows variation. It may be slender, with two rows of often widely spaced approximate fronds [e.g. *E. angustatum*, *E. acrostichoides*, *E. coniforme*, *E. drakensbergense*, *E. macropodium* and *E. spatulatum* (Fig. 1)]

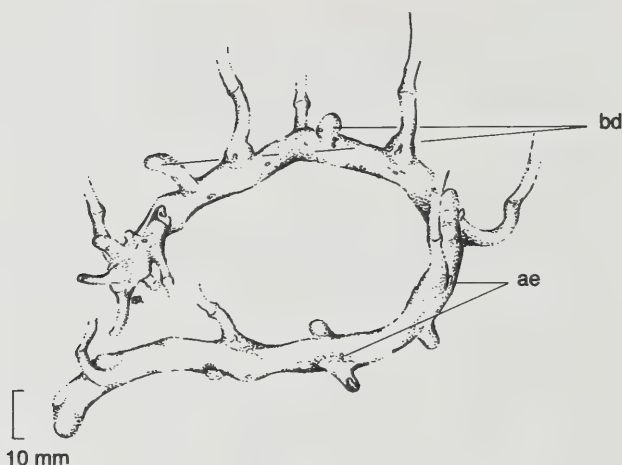


FIG. 1.

Habit of a dorsiventral rhizome, scales removed. *E. angustatum*, Roux 773 (NBG).  
ae: aerophores; bd: buds.

or short creeping, stout, and usually with four rows of caespitose fronds (e.g. *E. aubertii* and *E. hybridum*).

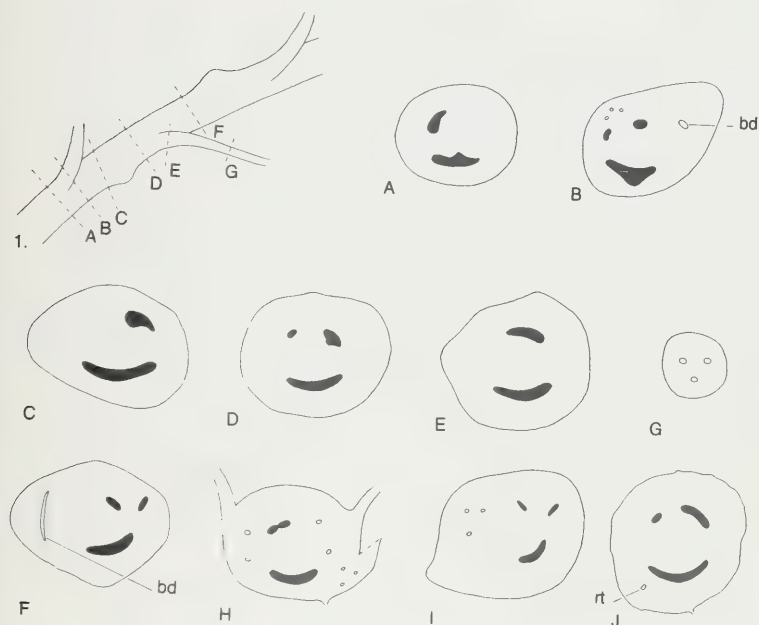
In some species conspicuous buds are situated on the rhizome on the posterior side of the phyllopodia. These buds often develop into accessory rhizome branches. When the older parts of the rhizome die off, these branches become separate and constitute an important method of asexual propagation.

#### RHIZOME STELE STRUCTURE

The rhizome consists chiefly of parenchymatous ground-tissue in which the rather small vascular strands are situated.

The stele is a dorsiventral dictostele. The dorsally very wide leaf-gaps are overlapping. The ventral part consists of an often broad, entire, shallow, channel-shaped strand. Root-traces arise irregularly from all over this strand.

Bell (1950 and 1955) recognised four forms of stelar symmetry. The South African taxa can be grouped into two of these. The first, which is the most simple and also the most common, is the dorsiventral two-ranked condition where bud-traces occur on the posterior side of each leaf-trace. The dorsal part usually consists of one or two cylindrical or irregularly shaped strands. Leaf-traces originate from the lateral sides of these strands (Fig. 2A-G).



Rhizome anatomy. A-G, *E. angustatum*, Roux 773 (NBG); 1 Schematic habit of rhizome: A-G, cross-sections as indicated in 1. H-J, cross-sections of rhizomes. H, *E. aubertii*, Roux 381 (NBG); I, *E. conforme*, Roux 774 (NBG); J, *E. acrostichoides*, Roux 780 (NBG). bd: bud-trace; rt: root-trace.

The three- or multi-ranked condition where bud-traces are associated only with the marginal leaf-traces is less frequent and of the relevant taxa occurs only in *E. aubertii* and *E. hybridum*.

In this condition the leaf-traces originate from the lateral sides of both the ventral and dorsal strands. (Fig. 2H-J). Bud-traces are only associated with the ventral rows of leaves.

#### AEROPHORES

Aerophores form part of the phyllopodia and are present on both sides of the phyllopodia (Fig. 1). Bell (1955) reported that these organs consist of loose parenchymatous tissue with large air-spaces and that stomata are present in the epidermis.



Aerophores show some form of variation. In *E. acrostichoides*, *E. angustatum*, *E. macropodium* and *E. conforme* the aerophores are small, oblong projecting organs, whereas those of *E. aubertii* and *E. hybridum* form a narrow linear wing which often extends beyond the point of articulation and may become confluent with the margins of the lamina. Aerophores were not observed in *E. drakensbergense* and *E. spathulatum*.

#### STIPE

The stipes of all the relevant *Elaphoglossum* species are articulated to phyllopodia which are part of the rhizome. Sporophyll stipes are always much longer than those of trophophylls. The stipes are firm; species such as *E. conforme*, *E. angustatum*, *E. acrostichoides*, *E. drakensbergense* and *E. spathulatum* have terete stipes whereas those of *E. aubertii* and *E. macropodium* are shallowly sulcate on the ventral surface. Towards the base of the lamina the stipe is always pale in colour, but deepens in shade towards the point of articulation.

The frequency of scales on the stipe can be extremely variable. Persistent scales are found in species such as *E. drakensbergense*, *E. spathulatum* and *E. hybridum*, whereas the scales in the other species are deciduous and generally more confined to the stipe bases.

#### STIPE ARTICULATION

Stipe articulation is a feature which is not more frequent in regions with seasonal climates as was stated by Wagner and Wagner (1977). Holttum (1968) pointed out that articulation is also a common feature in the wet tropics where a seasonal climate is non-existent. Articulation in this region is commonly associated with the epiphytic habit.

The sporophylls of species such as *E. conforme*, *E. angustatum*, *E. macropodium* and *E. acrostichoides* are short lived and tend to turn yellow soon after sporulation and then fall away. In *E. aubertii*, *E. hybridum*, *E. spathulatum* and *E. drakensbergense* the sporophylls are persistent for a long time after they have sporulated and died.

Trophophylls as a rule have a much longer lifespan than the sporophylls and tend to fall away only through climatological and/or physiological influences.

#### FROND ARCHITECTURE AND ORIENTATION

The characteristic simple and dimorphic frond pattern is found throughout the genus *Elaphoglossum*.

The trophophyll lamina of the relevant taxa varies from linear to elliptic, but in *E. spathulatum* the form varies from spatulate to ovate. The apex is

usually cuneate or obtuse while the base varies from cuneate to longly decurrent.

The coriaceous trophophyll lamina of *E. macropodium* reaches a length of up to 320 mm and a width of up to 70 mm while the trophophyll lamina of *E. spathulatum* reaches a mere length of 23 mm and a width of 12 mm.

The form of the sporophyll lamina varies from linear to rotund.

The sporophyll lamina of *E. macropodium* often reaches a length of 270 mm and a width of 40 mm while that of *E. spathulatum* reaches a length of 11 mm and a width of 10 mm.

Frond dimorphism is a character which embraces the whole frond in *Elaphoglossum*. The term, as used here, will be confined to the differentiation into spore-producing fronds or sporophylls, and sterile fronds or trophophylls.

It is widely believed that dimorphy appeared through evolutionary transitions, as fronds often do not continue to function in a double-duty state, but change from the primitive monomorphic ancestors. Theoretically, the necessity to carry out both duties, namely photosynthesis and spore production, may be eliminated if sporophylls evolve. This will permit the trophophyll and the sporophyll to become more efficient in their respective roles. Functions such as photosynthesis, spore production and spore dispersal were considered of prime importance by Wagner and Wagner (1977). They also observed that substantial differences often occur in the specialisation of the sporophyll and trophophyll. Special reference is made to various polypodioid genera where, as the sporophyll becomes longer and narrower, the trophophyll becomes shorter and wider.

They (Wagner & Wagner, l.c.), later stated that in *Elaphoglossum* the trend described above is regularly reversed as, "the trophophylls become linear, extremely long, narrow and pendent, while the sporophylls retain lanceolate outlines". It is not known on what evidence this statement is based, but it should be regarded as hypothetical due to the uncertain affinity and evolutionary trends in *Elaphoglossum*.

It is noted that the stipes of sporophylls of all the relevant species are much longer and usually also thicker than those of the trophophylls. Sporophyll laminae again are usually much smaller than those of the trophophylls except in *E. conforme* where the sporophyll is nearly as wide as the trophophyll (hence the name *conforme*). The result is that the sporophylls regularly overtop the trophophylls. This trend is the most common and should also serve more efficiently for spore dispersal by wind.

In a number of species, e.g. *E. acrostichoides*, *E. angustatum*, *E. conforme*, *E. drakensbergense*, *E. macropodium* and *E. spathulatum*, the sporophylls grow upright while the trophophylls are spreading. Theoretically this trend would prove more efficient photosynthetically. The size of the lamina

surface between sporophyll and trophophyll is also not very extensive. Although these taxa are found in forested areas they tend to be widespread and adaptable to more variable conditions. *E. aubertii* and *E. hybridum*, which are exclusively forest dwellers of the temperate regions, have sporophylls and trophophylls which grow erect. The lamina surfaces of the sporophylls in these species are much smaller than those of the trophophylls.

#### VENATION

Free venation is the condition most common in *Elaphoglossum*; reticulate venation, however, is not uncommon (Fig. 3).

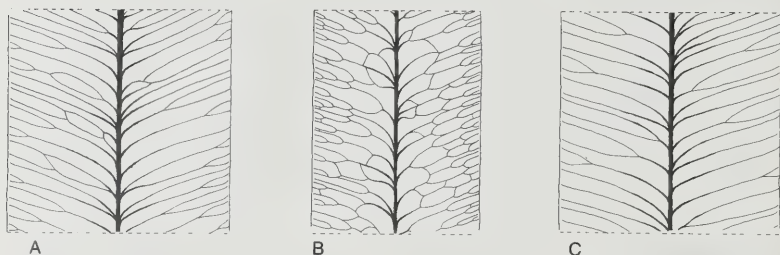


FIG. 3.

Schematic illustration of venation types. A and B, *E. hybridum*, A. trophophyll, B. sporophyll; C, *E. angustatum*, trophophyll.

Bower (1923), pointed out that some acrostichoid ferns have no special vascular provision for the nutrition of the sporangia. This does not apply to the relevant species as in all, except occasionally in *E. conforme*, the sporophylls have a more complex venation pattern than the trophophyll. Not only are the veins more closely spaced but the dichotomies are also more frequent (Table 1). Reticulate venation occurs in the sporophyll of *E. hybridum*. Although more sporadic, it also occurs in the trophophylls of this species as well as in those of *E. aubertii* and *E. macropodium*. The sporophylls of the latter species have a more complex free venation pattern.

*E. aubertii* is the only South African species of *Elaphoglossum* in which each vein in the trophophyll ends in a hydathode near the margin, a character which is absent in the sporophyll. The function of this organ is not fully understood but it may be of significance with regard to evolutionary changes which probably may have occurred in the sporophyll.

TABLE 1.  
Comparative studies in the sporophyll-trophophyll venation of *Elaphoglossum*

	Sporophyll		Trophophyll	
	Midrib	Margin	Midrib	Margin
<i>E. acrostichoides</i> .....	6-7	16-23	4-6	12
<i>E. angustatum</i> .....	4	13-14	3-4	6-8
<i>E. aubertii</i> .....	4-6	11-12	2-3	3-4
<i>E. conforme</i> .....	6-9	12-20	7-9	9-20
<i>E. drakensbergense</i> .....	7-9	17-19	4-6	14-16
<i>E. hybridum</i> .....	4-6	12-14	2-3	6-8
<i>E. macropodium</i> .....	4-5	8-10	3-5	8-10
<i>E. spathulatum</i> * .....	5	10	5	10

Counts were made within 10 mm along the midrib and again within 10 mm along the margin of the same frond. Sporophyll-trophophyll counts were made from the same plant.

\* As the sporophyll of this species seldom reaches a length of 10 mm the figure given is that of the entire frond.

## SCALES

In all species scales are found on the rhizome, stipe, midrib and lamina. These scales are variable in character depending on location and provide an important means of species discrimination.

The rhizome scales of all species, with the exception of *E. hybridum*, are scariose or with a few sclerified cells at the point of affixation. The scales of *E. hybridum* are sclerified throughout.

Rhizome scales vary in form from lanceolate to ovate. In *E. conforme* the scales are entire or crenulate whereas those of *E. drakensbergense* are shallowly dentate. The scales of all the other relevant taxa have few short or long filiform to cuneate filamentous marginal outgrowths. This character is more prominent in *E. acrostichoides* and *E. angustatum* where such outgrowths are numerous.

Stipe scales are usually scariose and deciduous. The stipe scales of *E. conforme*, *E. drakensbergense*, *E. hybridum* and *E. spathulatum* show no change in form from those on the rhizome. The general tendency of stipe scales is to become simplified. In *E. acrostichoides* the long filiform marginal outgrowths become a shallowly dentate margin and in *E. macropodium* the size of the outgrowths is reduced but become more frequent. In *E. aubertii* the scales become entire whereas those of *E. angustatum* become somewhat amorphous, as stellate scales are frequently found among rhizome-like scales.

Scales which are often very similar to those on the rhizome regularly extend to the lamina midrib. These scales are even more simplified than the stipe scales. In *E. angustatum* the scales become filiform to substellate.

The presence of scales along the midrib varies from sporophyll to trophophyll and from the ventral surface to the dorsal surface. In *E. macropodium*, *E. hybridum* and *E. angustatum* simple scales occur on both the ventral and dorsal surfaces of the sporophyll midrib. Simple scales however are confined to the dorsal surfaces of *E. conforme* and *E. acrostichoides*. The midrib on the ventral surfaces of these two species is glabrous.

In *E. macropodium*, *E. hybridum*, *E. conforme* and *E. acrostichoides* simple scales occur on the midrib of both ventral and dorsal surfaces of the trophophyll. Similar scales are confined to the dorsal surface of *E. angustatum*. The ventral surface of this species is glabrous.

Scales also occur on the lamina surfaces of *E. drakensbergense*, *E. spathulatum* and *E. aubertii*, but it is only on the dorsal surfaces of the trophophyll in *E. drakensbergense* that the scales are confined to the midrib.

On the dorsal surface of the *E. conforme* trophophyll there are numerous minute rotund to stellate scales which are often quite densely beset with firm, short or long, black spines which could be glandular hairs. Although these scales are more confined to the lamina base they may extend to the apex. During the early stages of their development they exude a resinous substance which makes the juvenile fronds sticky to the touch.

Conspicuous glands, similar to those which occur on the dorsal surface of the trophophyll of *E. drakensbergense*, remain once the scales have been removed.

Some form of dimorphism between sporophyll and trophophyll scales can be identified. A scaleless condition on both surfaces of the sporophyll occurs in *E. hybridum* and *E. aubertii*. In *E. aubertii* scales are abundant on both surfaces of the trophophyll but less frequent on the trophophyll lamina of *E. hybridum*.

In the sporophyll the ventral or upper surface of *E. drakensbergense* and *E. spathulatum* is densely paleate. No differentiation exists between the trophophyll and sporophyll scales in *E. drakensbergense*, but the sporophyll scales of *E. spathulatum* are generally enlarged. The dorsal or lower surfaces of the sporophylls in both these species are scaleless.

Lamina scales of *E. acrostichoides*, *E. conforme* and *E. macropodium* are highly simplified. On the ventral surfaces of the trophophyll these scales are infrequent and more often confined to the lamina bases. Scales similar in character are more frequently found on the dorsal surfaces. In *E. angustatum* simplified scales are more frequently found on the ventral and dorsal surfaces of the trophophyll.

With the exception of the dorsal surfaces of *E. drakensbergense*, both



ventral and dorsal surfaces of the trophophyll in *E. drakensbergense* and *E. spathulatum* are densely paleate. The trophophyll dorsal surface of *E. drakensbergense* has scales which are restricted to the midrib. These scales are slightly smaller than those along the midrib of the sporophyll.

The sporophyll scales, which are confined to the ventral surfaces of the lamina, are enlarged from the trophophyll scales in *E. acrostichoides* and *E. conforme* while those of *E. macropodium* remain unchanged from the trophophyll. The sporophyll scales of *E. angustatum*, which are more confined to the lamina base and midrib, are undifferentiated from those of the trophophyll.

Where differences in scales occur within a species it is noted that the trophophyll condition is usually simplified; for example rotund, subentire or shallowly serrulate and scariose.

Scale density on the trophophyll and sporophyll as an indication of evolutionary advancement remains a controversial subject.

#### SPORANGIUM

One of the characteristic features of *Elaphoglossum* is the acrostichoid sori. Sporangia with stalks of variable length are densely crowded on the dorsal surface of the sporophyll. Ripening of the sporangia is irregular.

The interrupted row of large annulus cells is relatively prominent with the exception of *E. hybridum* which has rather small annulus cells. The number of cells is most variable in *E. acrostichoides*. In this species it varies between 8 and 14. The most general figure recorded in the relevant taxa is 12 cells per sporangium.

#### SPORES

Spores, when studied with the electron microscope, show considerable variation. The spore wall in most species has slender or short crests but in *E. drakensbergense* and *E. spathulatum* the spore wall forms low undulating ridges. The monolet structure of the spore is also most prominent in these taxa (Fig. 5C-F).

The surfaces are usually densely ornamented with short distinctive spinules, but in some species this is absent. In species such as *E. acrostichoides* the crests are perforated (Fig. 4C-D).

Mickel and Atehortúa (1980) studied spores of a considerable number of taxa and they noted that the spore morphology proved to be quite useful in confirming presumed relationships within their system of generic breakdown.

#### JUVENILE FRONDS

The juvenile fronds of all the species studied are morphologically remarkably similar to the mature fronds. The frond architecture remains sim-

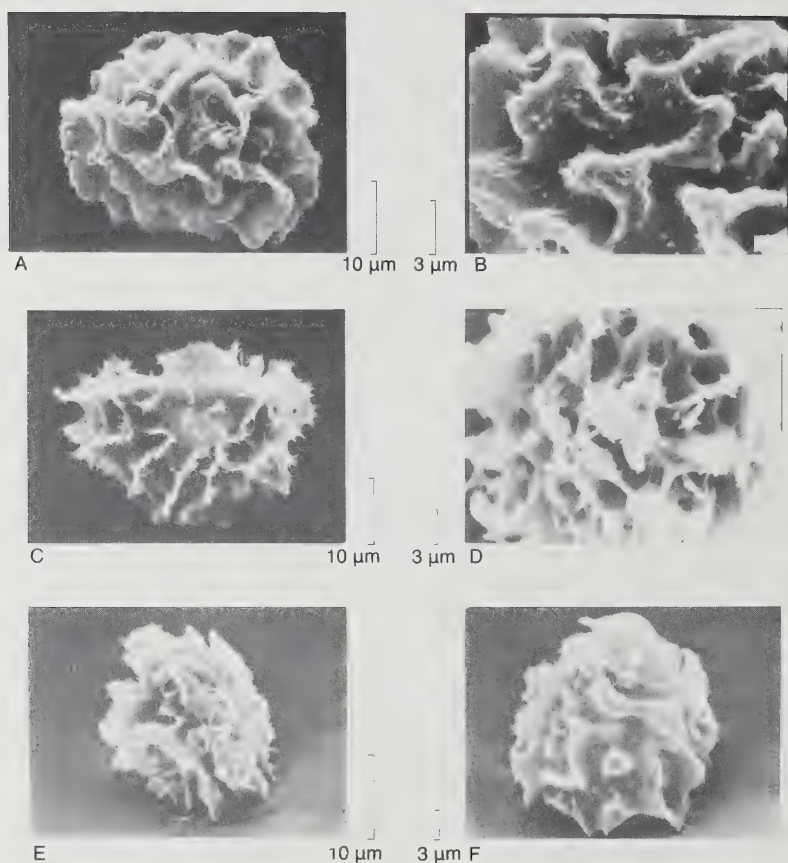


FIG. 4.

Spores of *E. conforme*, *E. acrostichoides* and *E. macropodium*. A and B, *E. conforme*, Roux 775 (NBG), C and D, *E. acrostichoides*, C, Roux 306, D, v. d. Zeyde s.n. (NBG); E and F, *E. macropodium*, Roux 382 (NBG).

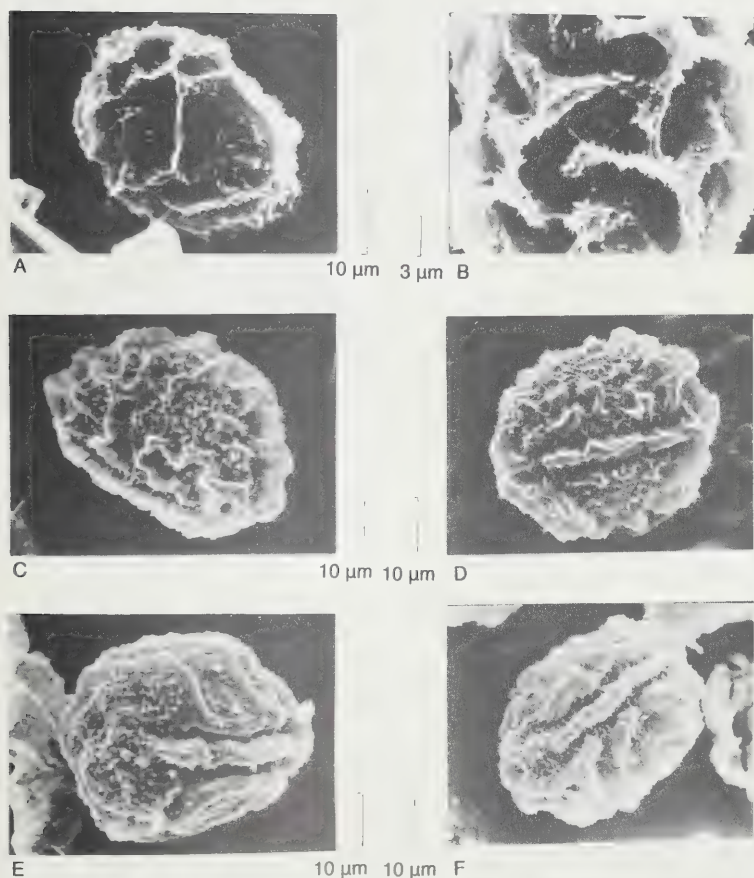


FIG. 5.

Spores of *E. angustatum*, *E. spathulatum* and *E. drakensbergense*. A and B, *E. angustatum*, Roux 773 (NBG); C and D, *E. spathulatum*, Roux 970 (NBG); E and F, *E. drakensbergense*, Roux 824 (NBG).

ple and the scales show no significant variations from that of the mature state. Also the venation remains free (Fig. 6).

Of special interest is the persistence of the juvenile fronds during the first stages of development. Articulation can therefore be considered as representing a derived condition. This however needs further investigation.

#### JUVENILE FRONDS AND PHYLOGENY

There are two fundamental plans of frond organisation; dichotomous and monopodial. The dichotomous form, critically analysed by Wagner (1952) does not occur in the genus *Elaphoglossum*.

As the juvenile plants are morphologically remarkably similar to the mature plants they are of interest as theoretically, the phylogeny should be based on evidence obtained from all ontogenetic developmental stages of the life-cycle. It can therefore be assumed that in *Elaphoglossum* the tendency of diversification, or simplification, as is generally believed to take place in some fern groups, has been partially lost. This appears to be a typical example of neotony as the simple phenotype, with its complex genotype, maintained its evolutionary plasticity.

#### SYSTEMATICS

**Elaphoglossum** Schott ex J. Smith in Hook. Journ. Bot. 4: 148 (1841) nom. cons. Type: *E. conforme* (Sw.) J. Smith in Hook. Journ. Bot. 4: 148 (1841). Habitat in Insula St. Helenae, *Masson s.n.* (UPS-THUNB, holo.!).

Epiphytic, lithophytic or terrestrial, of moderate size or small; rhizome dorsiventral, short or long, creeping, branched, paleate; stipe approximate or caespitose, articulated to enlarged phyllopodia which arise from the rhizomes; fronds dimorphic, stipes of sporophylls usually longer than that of trophophyll; lamina simple, entire, firmly herbaceous to coriaceous, moderately to densely paleate; sporophyll much smaller and narrower than trophophyll except in *E. conforme*; veins evident or immersed, dichotomously branched, parallel, free or reticulate; sori acrostichoid, sporangia sphaeroidal to somewhat compressed, annulus cells 8–14, usually 12; spores monolete, rotund to ellipsoid, brownish to black.

#### KEY TO THE SOUTH AFRICAN SPECIES OF *ELAPHOGLOSSUM*

- 1a Trophophyll lamina glabrous or with numerous minute, appressed, peltate, subrotund to stellate scales.
  - 2a Rhizome scales scariose, entire to crenulate; scales on dorsal surface of trophophyll lamina rotund to stellate, glandular ..... 1. ***E. conforme***
  - 2b Rhizome scales scariose or sclerified, with few or numerous filamentous outgrowths, lamina not glandular.
    - 3a Trophophyll lamina linear to narrow-lanceolate; up to 240 × 27 mm at maturity ..... 2. ***E. acrostichoides***

- 3b Trophophyll lamina oblong to elliptic; up to 320 × 70 mm at maturity.
- 4a Trophophyll coriaceous; narrow to broad-elliptic; stipe scales ovate, more or less confined to the base, scales with short filamentous outgrowths along margin . . . . . 3. *E. macropodium*
- 4b Trophophyll herbaceous; linear to narrow-elliptic; stipe scales amorphous, not confined to the lamina base . . . . . 4. *E. angustatum*
- 1b Trophophyll lamina densely scaled or with prominent scales at least along the midrib and margin.
- 5a Trophophyll less than 100 mm long at maturity; sporophylls ventrally densely scaled.
- 6a Dorsal surface of trophophyll scaled . . . . . 5. *E. spatulatum*
- 6b Dorsal surface of trophophyll with scales confined to the midrib . . . . . 6. *E. drakensbergense*
- 5b Trophophyll more than 100 mm long at maturity; sporophylls ventrally scaleless.
- 7a Trophophyll lamina scaled ventrally and dorsally; trophophyll veins end in hydathodes near margin . . . . . 7. *E. aubertii*
- 7b Trophophyll lamina scales mainly confined to the midrib and margin; trophophyll veins not ending in hydathodes . . . . . 8. *E. hybridum*

1. *Elaphoglossum conforme* (Sw.) J. Smith in Hook. Journ. Bot. 4: 148 (1841).

*Acrostichum conforme* Sw., Syn. Fil.: 10, 192, t.1, f.1 (1806). Type: Habitat in Insula St. Helenae, *Masson s.n.* (UPS-THUNB no. 24405, holo.). **Figs 7 and 8A–D.**

*Olfersia conformis* (Sw.) C. Presl, Tent. Pterid.: 235 (1836).

*Acrostichum oblongum* Desv. in Mag. Ges. Naturf. Berl. 5: 308 (1811). Type: Habitat in C. bonae Spei, in Herb. Desvaux (P, holo.).

*Acrostichum glandulosum* Carm. ex Hook. & Grev., Ic. Fil.: t.3 (1830). Type: Cape of Good Hope, *Carmichael s.n.* (K, holo.).

*Acrostichum conforme* Sw. var. *glandulosum* (Carm.) Fée, Mém. Fam. Foug. 2: 34 (1845).

*Acrostichum viscosum* Sw. var. *rupestre* Sim. Ferns S. Afr., ed. 1: 222, t.82, f.2 (1892) pro parte. Type: Table Mountain, *Bolus 3899* (BOL, lecto.).

*Elaphoglossum petiolatum* (Sw.) Urban var. *rupestre* (Sim) Sim, Ferns S. Afr., ed. 2: 288, t.150, f.2 (1915).

Rhizome creeping, branched, up to 5 mm diam., verruculate, glutinose, phyllopodia 5–11 mm long, black, aerophores small, rhizome densely set with pale brown, scariose, lanceolate, crenulate to entire scales, up to 5 × 1.5 mm; stipe approximate, firm, trophophyll stipe up to 160 mm long, sporophyll stipe usually longer than that of trophophyll, up to 270 mm long, with pale brown, scariose lanceolate to cuneate, entire to crenulate scales more frequent at base, up to 7 × 2 mm; trophophyll simple, entire, coriaceous, oblong to elliptic, base acute to longly decurrent, up to 170 × 40 mm, venation free, midrib shallowly sulcate ventrally, ventral surface with pale



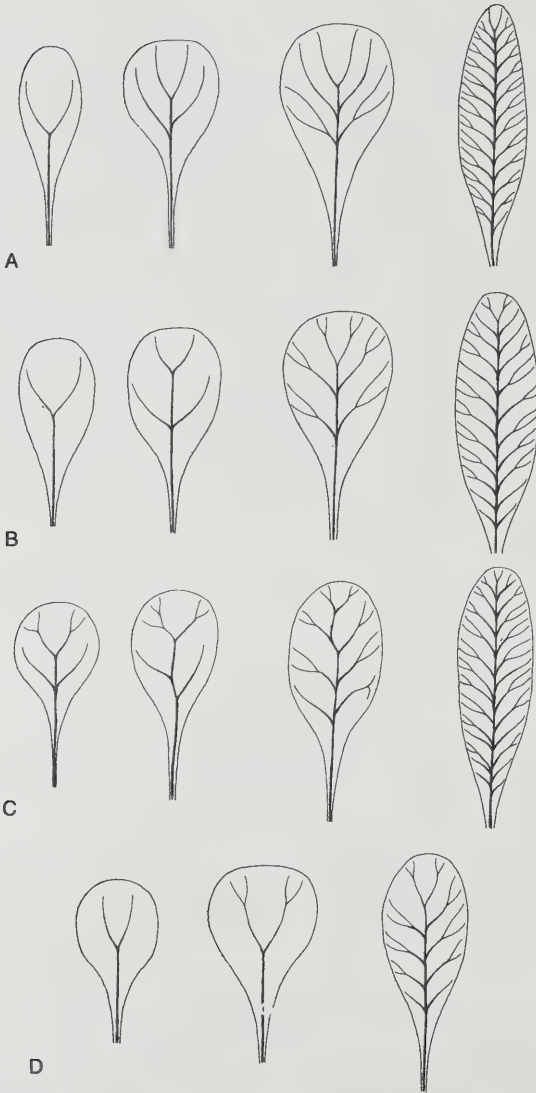


FIG. 6.

Series of juvenile fronds. A, *E. acrostichoides*, Roux 780 (NBG); B, *E. conforme*, Roux 774 (NBG); C, *E. angustatum*, Roux 773 (NBG); D, *E. spathulatum*, Roux 885 (NBG).



FIG. 7.  
*E. conforme*, habit. Roux 775 (NBG).

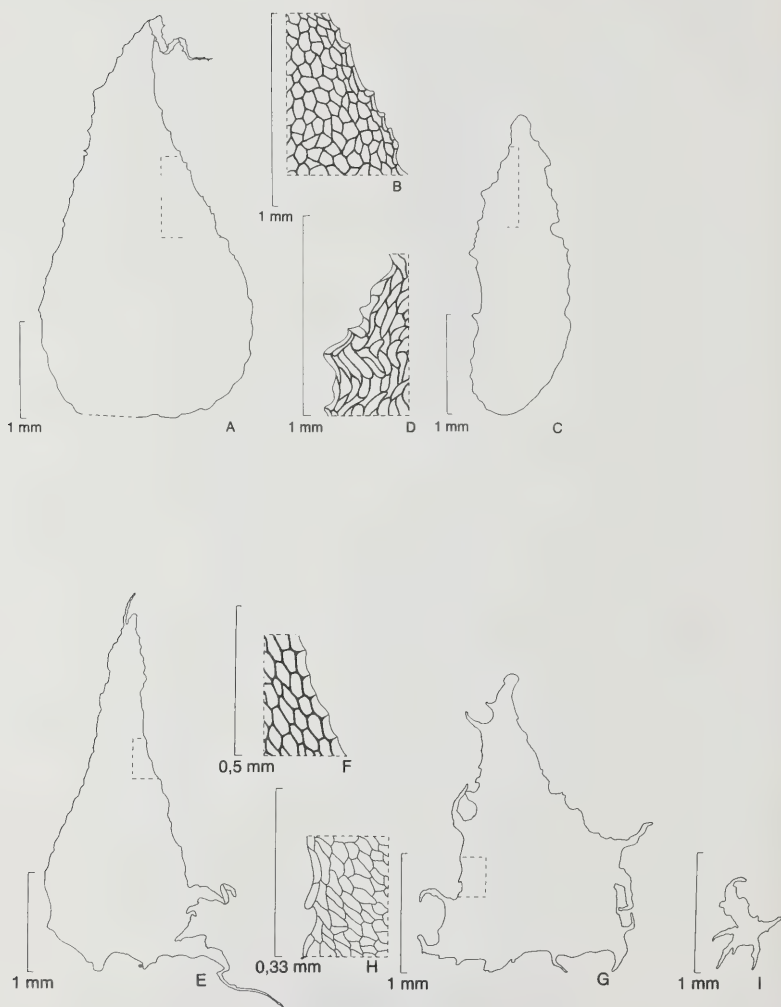


FIG. 8.

Scales of *E. conforme*, Roux 775 (NBG) and *E. acrostichoides*, v. d. Zeyde s.n. (NBG). A-D, *E. conforme*. A. rhizome scale; B. detail; C. trophophyll scale from dorsal surface, midrib; D. detail. E-I, *E. acrostichoides*. E. rhizome scale; F. detail; G. trophophyll scale from dorsal surface; H. detail; I. trophophyll scale from ventral surface.

*Fern genus Elaphoglossum Schott (Filicales) in S.A.*

brown, scariose, ovate, entire to shallowly crenulate scales, up to  $4.5 \times 1$  mm, confined to lamina base and midrib, minute, rotund, peltate scales frequent on lamina, dorsal surface with scariose, lanceolate to ovate scales confined to midrib, minute rotund to stellate spinose resin-exuding scales more frequent on lamina; sporophyll simple, entire, coriaceous, oblong to elliptic, up to  $135 \times 27$  mm, venation free, ventral surface with pale brown, ovate scales with numerous filamentous outgrowths along margin, frequent along midrib, minute sclerified, substellate to stellate, peltate scales frequent on lamina, not absent on dorsal surface; sori acrostichoid, annulus large, 11–13 (12)-celled; sporoderm undulate, reticulate, ridges up to  $5 \mu\text{m}$  high, crest more or less smooth, areas between papillate, 39–42  $\mu\text{m}$  diam.

*Elaphoglossum conforme* is represented in the Swartz herbarium by a rhizome fragment only. This sheet originally formed part of the Cassstrom collection. Neither collector nor locality are provided. The possibility that it formed part of the original Masson collection should not be overlooked.

The material which is at present accepted as the type of Desvaux's *Acrostichum oblongum* consists of a mixed collection. The largest portion of the material—the specimen in the centre and bottom right—fits Desvaux's description very well. This is *E. conforme*. The specimen on the left of the sheet appears to form part of the collection on a second sheet. Desvaux also named this *A. oblongum*. It is, however, *E. angustatum* (Schrad.) Hieron.

The material on which Carmichael based his *Acrostichum glandulosum* is a typical xeromorphic form. The plants are depauperate and excessively glandular.

Sim's treatment of *Elaphoglossum* (1892: 1915), should be disregarded in all respects. His *A. viscosum* var. *rupestre* (1892), which he later called *E. petiolatum* var. *rupestre* (1915), should obviously be *E. conforme* (Sw.) J. Smith.

#### PHYTOGEOGRAPHY AND ECOLOGY

*Elaphoglossum conforme* appears to be restricted to the Table Mountain range on the Cape Peninsula and the immediate surrounding mountains in the South-western Cape. The geology of the area consists entirely of Table Mountain Sandstone (Fig. 10).

At Woodhead, on Table Mountain (alt. 747 m), where this species is relatively common, the precipitation measures 1 623 mm per annum. Mists are frequent throughout the year but more so at altitudes above 600 m.

The distribution of *E. conforme* is more or less restricted to altitudes above 500 m. Habitats vary from wet conditions in deeply shaded ravines to small caves and rock overhangs. At higher altitudes where the plants are more frequently found they tend to be confined to seasonally dry rock cre-

ices on low cliffs. In conditions such as these, exposure and severe climatic conditions such as high winds and dry summer months (November–February) cause the plants to be extremely depauperate.

Hemicyptophyte (lithophytic). Meso- xerophilous, fronds xeromorphic, articulated. Seasonal pattern irregular. Effective vegetative propagation by branched, creeping rhizome. Sporelings are rarely found in moist rock crevices or on permanently moist rock faces.

#### PHENOTYPE VARIATION

The most significant degree of variation observed in *E. conforme* was in frond size. This is largely due to the habitat of the plant. Plants growing in moist protected situations may have fronds up to 370 mm long whereas plants in exposed xeric conditions may have fronds that are merely 70 mm long.

The South African phenotype varies in numerous ways from the type collection. The cell-walls of the rhizome scales in the type material are more or less straight, whereas in the South African material the cell-walls are much twisted. No scales extend to the lamina midrib nor are any scales present on the lamina surfaces. In the type material the lamina is also very sparsely glandular. Xeromorphs appear to be more glandular.

#### MATERIAL EXAMINED

CAPE—3318 (Cape Town): Table Mountain, Cape Peninsula (-CD), 13/11/1963, *Esterhuysen 30541* (BM, C, NBG); Table Mountain, below reservoirs, -/11/1919, *Michell s.n.* (NBG); Corrells Ledge, Table Mountain, 23/2/1941, *Bond 963* (NBG); Top of Table Mountain, above Kirstenbosch, 13/10/1976, *Roux 93* (NBG); Woodhead Saddle, Table Mountain, 28/11/1897, *Froembling 394* (NBG); Between Table Mountain and Devils Peak, 24/1/1946, *Schelte 1181* (NU); Table Mountain, -/2/1887, *Thode 27436* (STE); Table Mountain, Disa Gorge, 10/11/1963, *Esterhuysen 30540* (BM, C); Table Mountain, Grotto Ravine, 8/9/1963, *Esterhuysen 30332* (BM); Table Mountain, Grootkop area, 18/7/1963, *Esterhuysen 30268* (BM, C); Table Mountain, *Harvey s.n.* (BM); Devils Peak, 9/9/1883, *Wilms 3906A* (BM, G); Tafelberg Plateau, 27/7/1883, *Wilms 3906* (BM, K); Table Mountain, *sine coll.* (K); Spitz des Devilspeak, 9/9/1883, *Wilms s.n.* (G, K); Kloof beyond Kirstenbosch, 26/9/1896, *Wolley-Dod s.n.* (K); Tafelberg, 20/9/1958, *Werdermann & Oberdieck 34* (K). —3319 (Worcester): Dutoitskloof (? et Genadenthal) (-CA-CC), *Drège s.n.* (B). —3418 (Simonstown): Southern aspect, Constantiaberg, Cape Peninsula (-AB), 8/3/1940, *Bond 188* (NBG). Without exact locality: C.B.S., Ex Herb. Hooker, -/-/1867 (K); Cap, -/8/1845, *Drège s.n.* (G); C.B.S., *Wilce s.n.* (C); Pr. b. Sp., *Gueinzus s.n.* a-d (S); Cap b. Sp., *Warwa 50*—except central bottom specimen (W); Cap b. Sp., *Bojer s.n.* (W); Cap, *Scholl s.n.* (W); *Barkley 138* (GRA).

2. *Elaphoglossum acrostichoides* (Hook. & Grev.) Schelte in Jl S. Afr. Bot. 30(4): 196 (1964). Figs 8E–I and 9.

*Vittaria acrostichoides* Hook. & Grev., Ic. Fil.: t.186 (1830). Type: Cape of Good Hope, *Carmichael s.n.* in Herb. Hooker (K, holo.!).



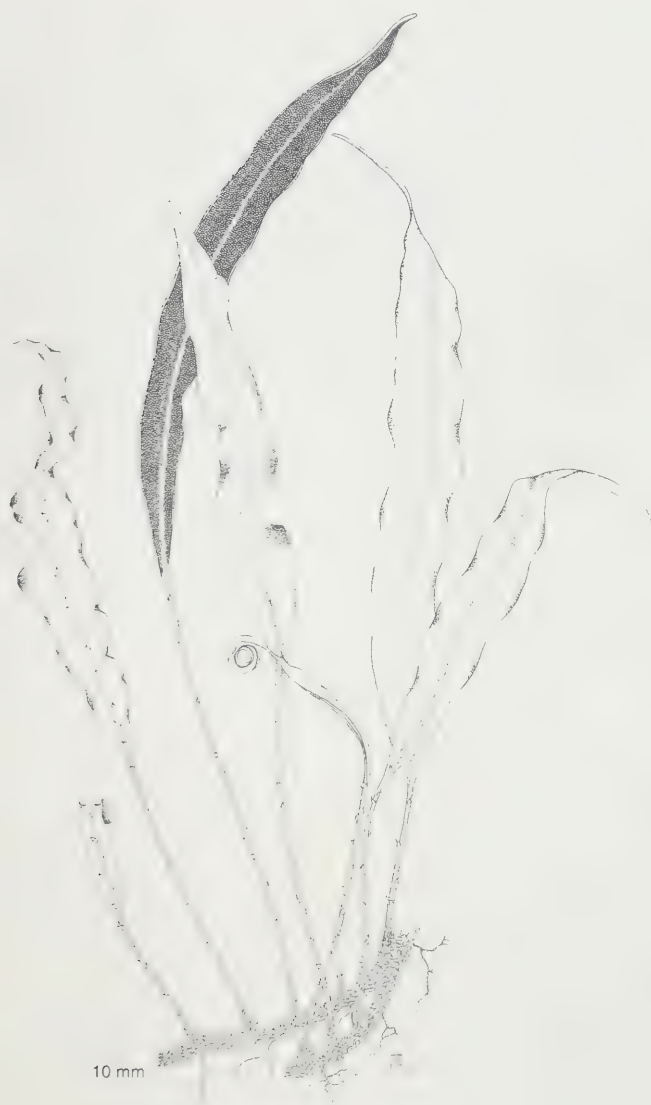


FIG. 9.  
*E. acrostichoides*, habit. v. d. Zeyde s.n. (NBG).

*Drymoglossum acrostichoides* (Hook. & Grev.) Moore, Ind. Fil.: 31 (1857).

*Acrostichum lineatum* Kuhn ex Christ, Monogr. Elaph.: 146 (1889) non Cav. (1799). Type: Madagascar, S. Betsileo, Ankafina, *Hildebrandt* 4179 (B, holo.!).

*Elaphoglossum conforme* (Sw.) Schott var. *lineatum* (Kuhn ex Christ) C. Chr. in Perrier, Cat. Pl. Madag.: 61 (1932).

*Elaphoglossum preussii* Hieron. in Bot. Jahrb. 46: 402 (1911). Type: Buea, Wald 1/2 Std. westlich von den Höhlen westlich von Buea, *Preuss* 937 (B, holo.!; P, iso.!).

*Acrostichum conforme* (Sw.) Schott var. *angustata* Kunze in Linnaea 10: 495 (1836) reimpr. as Pl. Acot.: 15 (1836). Type: Promont. bon. Spei, in cacumine, *Bergius s.n.* (B, lecto.!); *Burchell* Catalogus Geographicus Plantarum Africae Australis Extratropicae no. 479. in Herb. De Candolle (G, syn.!).

Rhizome creeping, branched, up to 3,5 mm diam., phyllopodia 2–7 mm long, black, aerophores large, rhizome densely set with lanceolate scales which are entire or have a few filamentous outgrowths at the sclerified base, up to  $5 \times 2$  mm; stipe approximate, terete, firm, pale green, trophophyll stipe up to 180 mm long, sporophyll stipe usually longer than that of trophophyll, up to 190 mm long, with few deciduous, scariose, ovate scales with few filamentous outgrowths along margin, up to  $2,5 \times 1,5$  mm; trophophyll simple, entire, firmly herbaceous, linear, longly decurrent to base and apex, midrib shallowly sulcate ventrally, up to  $243 \times 27$  mm, venation free, ventral surface glandular, with few deciduous, scariose scales similar to those on stipe along midrib, minute, frequent pale rotund scales on lamina, dorsal surface glandular, with few deciduous, scariose scales along midrib and numerous minute, pale brown, scariose, stellate scales on lamina; sporophyll simple, entire, firmly herbaceous, linear, base longly decurrent to cuneate, midrib shallowly sulcate ventrally, up to  $175 \times 15$  mm, venation free, ventral surface glandular, with numerous minute, pale brown, scariose, stellate scales, dorsal surface glabrous; sori acrostichoid, often incomplete at base, annulus large, 8–14 (12)-celled, sporoderm deeply and irregularly undulate, forming short reticulate ridges with pores at base, crest spinulose, areas between scabrous, 40–45  $\mu$ m diam.

The identity of *Vittaria acrostichoides* Hook. & Grev. remained a mystery for more than 130 years. Fée was doubtful about the identity of this species as in his *Histoire des Vittarées et des Pleurogrammées* (1851–1852) he remarked that it could belong to the genus *Pteropsis*.

Moore (1857), also uncertain about the identity, placed the species in the genus *Drymoglossum*. By 1868, Hooker and Baker realised that this plant

was not a *Vittaria* but an "*Acrostichum*". Under *A. conforme* they remarked that "*Vittaria acrostichoides* Hook. & Grev. is an abnormal form, with the fruit in two submarginal lines".

Sim's treatment of *Elaphoglossum* (as *Acrostichum*) in the first edition of his *Ferns of South Africa* (1892) led to further confusion. He wrongly identified specimens of *E. acrostichoides* with the tropical American *Acrostichum viscosum* Sw. (a later name for *A. petiolatum* Sw.). In the *Index Filicum* (1905) Christensen followed Christ in recognising the genus *Elaphoglossum*, but copied the error of Hooker & Baker in recording *Vittaria acrostichoides* as a synonym of *E. conforme*. In Sim's second edition (1915), he adjusted his generic names to those of Christensen, but in dealing with *E. acrostichoides* he merely altered *Acrostichum viscosum* to *Elaphoglossum petiolatum*.

When preparing the *Flora of the Cape Peninsula*, Adamson (1942) made an attempt to clarify this problem but failed. His *E. conforme* is, in fact, *E. acrostichoides*.

It was only in 1964 that *Vittaria acrostichoides* was referred to as an *Elaphoglossum* by Schelpe.

#### PHYTOGEOGRAPHY AND ECOLOGY

*E. acrostichoides* is the most widespread of the South African species of *Elaphoglossum*. The species occurs through a wide range of geological formations but is strictly confined to the higher rainfall zones. In the Cape, it is probably confined to the parts south and east of the major mountain ranges while in Natal, the Orange Free State and Transvaal the species is more commonly found along the Drakensberg escarpment and the immediate surrounding areas (Fig. 10).

In the Cape, Transvaal and the lower lying southern parts of Natal, the species is more or less restricted to Table Mountain Sandstone. Higher up, in the Natal midlands and the eastern Free State, the species is more confined to Cave Sandstone.

Precipitation varies from 906 mm at Tzaneen to 1 341 mm per annum at Nkandhla. Mists are frequent throughout the year in the mountainous parts. At Harrismith and Kokstad the species occurs within the snowline. Snowfalls however are irregular.

Due to the extensive distribution range of *E. acrostichoides*, the habitat also varies considerably. Plants have been recorded from deeply shaded, wet mist forests to xeric conditions along the Drakensberg escarpment.

Hemicryptophyte (geophytic, lithophytic or epiphytic). Mesophilous, fronds meso- xeromorphic, poikilohydrous, articulated. Seasonal pattern regular. Effective vegetative propagation by branched, creeping rhizome. Sporelings are commonly found in moist situations.

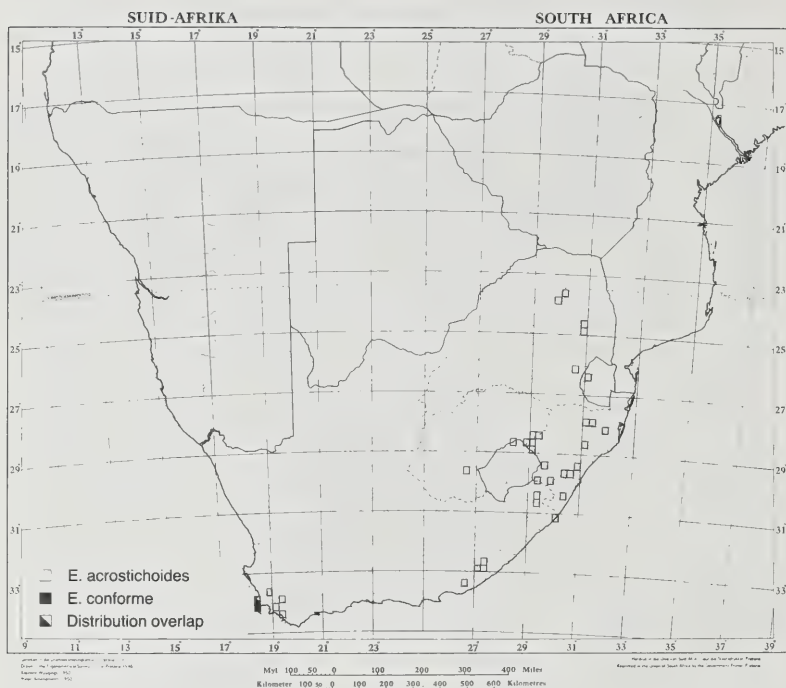


FIG. 10.  
Distribution map of *E. conforme* and *E. acrostichoides*.

The plants appear to be largely influenced by climate. Fertile fronds are commonly found towards the end of the summer within the same climatological region. When looking at the distribution as a whole, there would appear to be no detectable distribution pattern.

## PHENOTYPE VARIATION

Variation is most extensive in frond size. This is largely due to the topography and the wide range of climatological influences which are experienced within the geological distribution.

Depauperate forms are frequent in exposed and xeric conditions. Such plants usually have entirely sclerified, subentire rhizome scales.

## MATERIAL EXAMINED

TRANSVAAL—2329 (Pietersburg): Houtbosch (-DD), *Rehmann* 3593 (K).

—2330 (Tzaneen): Westfalia Estate near Duivelskloof (-CA), 10/3/1977, *van Jaarsveld* 1902 (NBG); Woodbush, *Eastwood* 157 (GRA).

—2430 (Pilgrims Rest): Mariepskop, near summit (-DB), *Schweickerdt* 2439 (NU); Mariepskop plateau, 24/1/1968, *Strey* 7910 (NH); Mariepskop, near waterfall, 6/12/1961, v. d. Schyff 5902 (K); On top of Mariepskop, 5/1/1960, v. d. Schyff 4825 (W); Klaserie waterfall, Mariepskop, 6/1/1960, v. d. Schyff 4928 (W); Kovyns Pass (-DD), 12/6/1946, *Schelpel* 1 648 (NU); In cinvallibus-Drakensbergen—"Pilgrims Rest Gold Fields", -/6/1894, *Bolus* 1730 (SAM); Graskop, Fairyland, 6/1/1979, *Roux* 394 (NBG).

—2630 (Carolina): Near The Brook, between boulders (-BA), 2/11/1968, *Strey* 8014 (NH).

ORANGE FREE STATE—2828 (Bethlehem): Witsieshoek (-DB), -/3/1896, *Thode* 6248 (STE).

—2829 (Harrismith): Donkey's Pass, Platberg (-AC), 28/6/1980, *Roux* 799 (NBG); Farm Bosch Hoek (-AD), 5/11/1980, *Roux* 847 (NBG); Farm Bosch Hoek, eastern slopes of Manyenzea, 5/11/1980, *Roux* 850 (NBG); In umbrosis pr. Van Reenen, 2/3/1895, *Schlechter* 6917 (GRA, SAM); Van Reenen, -/2/1908, *Thode* 4183 (STE); Klavervlei, on Seheletwane (-CA), 30/10/1980, *Roux* 828 (NBG); Klavervlei, between sandstone boulders, 30/10/1980, *Roux* 834 (NBG).

—2926 (Bloemfontein): Near Collingham (-DA), 11/9/1926, *Britten* 5417 (GRA).

SWAZILAND—2631 (Mbabane): Hill NE of Mbabane (-AC), 27/5/1958, *Comp-ton* 27849 (NBG).

NATAL—2731 (Louwsburg): Injasuti, Natal (-CC), 7/4/1950, *Johnstone* 420 (NU); Ngome Forest, Ngotshe Distr. (-CD), 10/2/1962, *Tinley* 713 (NU); Ngome forest, 26/10/1952, *Johnstone* 629 (NU); Daycott Hill (-DC), 19/4/1945, *Acocks* 11446 (NH).

—2831 (Nkandhla): Nhlwati, Hlabisa Distr. (-BB), 28/3/1954, *Ward* 2262 (NU); About 20 miles N of Qudeni Police St. (-CA), -/2/1940, *Fisher & Schweickerdt* 130 (NH).

—2828 (Bethlehem): Sunday Falls, Royal Natal National Park (-DB), 6/11/1946, *Schelpel* 1813 (NH); Gudu Forest, Mount aux Sources, 13/4/1946, *Schelpel* 1569 (NU).

—2829 (Harrismith): Little Switzerland, Oliviershoek (-CA), 16/3/1981, *Roux* 967 (NBG); nKdhanhla Forest, Cathedral Peak area (-CC), *Schelpel* 753 (NU); Indumeni Forest, Cathedral area, -/7/1944, *Schelpel* 714 (NU); nKdhanhla Forest, Cathedral area, -/7/1943, *Schelpel* r38, *Schelpel* p23 (NU); Indumeni River Valley, Cathedral Peak area, 14/2/1952, *Killick* 1673 (NU).

—2929 (Underberg): Aamberg, Game Pass (-BC), -/12/1947, *Gordon-Gray* 76 (NU); Polela River Valley, Cobham Forestry Reserve (-CD), 6/12/1978, *Cowan* 153 (NU); Upper Polela Cave, Cobham Forestry Reserve, 10/3/1979, *Cowan* 163 (NU); *Hilliard & Burt* 12554 (NU); Bulwer (-DD), 14/4/1945, *Clarkson* 185 (NU); Bulwer, -/6/1943, *Henkel* s.n. (NU).

—2930 (Pietermaritzburg): Kingcliffe, New Hanover Distr. (-BD), 5/1/1965, *Moll* 1511 (NU); Zwartkop, Pietermaritzburg (-CB), -/1/1916, *Carnegie* 752 (NU); Table Mountain, Natal (-DA), -/6/1947, *Johnstone* 125 (NU); Table Mountain, Natal, -/5/1947, *Ward* 100 (NU).

—3029 (Kokstad): Mt. Curry, East Griqualand (-AD), *Edwards* 116 (NU); Farm Westlands, Kokstad (-CB), 14/1/1979, *Roux* 430 (NBG).

—3030 (Port Shepstone): Hlokozi, Umzimbi, Alexandra Country (-AD), 17/1/1919, *Rudatis* s.n. (STE).

—3130 (Port Edwards): Isingolweni road (-AA), -/1/1951, *Huntley* 748—top left and bottom right specimens (NU).

LESOTHO—2828 (Bethlehem): Lirebe (-CB), *Dieterlen* 679 (NBG).

CAPE—3227 (Stutterheim): Evelyn Valley, Stutterheim (-CB), 13/1/1967,



*Compton* 19229 (NBG); Mt. Kemp, Keiskamma Hoek Distr., 26/4/1950, *Killick* 913 (NU); Evelyn Valley, Stutterheim, *Taylor* 4198 (NBG); Kingwilliamstown (-CD), -/1892, *Sim* s.n. (NU); Dohne Mountains, Kaffraria, -/1894, *Sim* s.n. (STE).  
 —3318 (Cape Town): In Monte tabul., Cap b. Sp. (-CD), *Ecklon* s.n. (C); Prom. bonae Spei, in monte Tabilari, *Rehmann* 696 (W); Fernwood Gully, Table Mountain, 30/7/1977, *Roux* 175 (NBG); Disa Gorge, Table Mountain, 2/1/1977, *Roux* 96 (NBG); Table Mountain, *Rawson* s.n. (SAM); Berg River Hoek, Paarl (-DB), 4/10/1942, *Compton* 13861 (NBG); Asgaaibosch, Stellenbosch, 20/8/1947, *STE* 31226 (STE); Van Brackels Kloof, Stellenbosch, -/5/1920, *Garside* 1471 (K).  
 —3319 (Worcester): Silverstreams, east of Villiersdorp (-CD), 23/11/1974, *Olivier* 5493 (STE).  
 —3326 (Grahamstown): Paradise Kloof, Coldspring (-BC), 11/2/1924, *Britten* 5081 (GRA); Amos Kloof, Grahamstown, -/1864, *Holland* s.n. (SAM); In umbrosis rupestris fissuris, Grahamstown, *McOwan* 1246 (SAM).  
 —3419 (Caledon): Grabouw, Lebanon Forest Reserve (-AA), 5/4/1967, *Kruger* 369 (STE); In monte Zwartberg-Caledon (-AD), -/8/-, *Ecklon & Zeyher* s.n. (SAM); Caledon, SAM 24977—specimen on left (SAM).  
 Without exact locality: Himeville Distr., -/1/1944, *Webb* 116 (NH); Inanda to Drakensberg, *Buchanan* s.n. (NH); 26310, 26622A, 9748 (NH); *Carnegie* s.n. (NU); Natal, *Wood* s.n. (NU); *STE* 27438 (STE); Cape of Good Hope, -/1822, *Carmichael* s.n. (K); C.B.S., *Zeyher* s.n. (K); O.F.S., *Cooper* 1053 (K); Cape of Good Hope, -/3/1873, *Cooper* 2907 (K); Natal, *Buchanan* s.n. (K); Promontorio bonae Spei, *Gueinzus* s.n. (G); Port Natal, *Gueinzus* s.n. (C); Pr. b. Sp., *Gueinzus* s.n. e-h (S); Natal, on trees, *Sanderson* 14 (S); Cap b. Spei, *Warwa* 50—specimen in centre at bottom of sheet (W); Cap b. Spei, *Ecklon* s.n.; Cap b. Sp., *Bojer* s.n.; Cap b. Spei, *Ecklon & Zeyher* s.n.; Cap, *Drège* s.n.; Orange Free State, -/1862, *Cooper* 1053 (W).

### 3. *Elaphoglossum macropodium* (Fée) Moore, Ind. Fil.: 11 (1857). **Fig. 11A–F.**

*Acrostichum macropodium* Fée, Mém. Fam. Foug. 2: 30, t.6, f.2 (1845). Type: In Borbonia. in Herb. M. Bory de St. Vincent (P, holo.).

Icones: Fée, Mém. Fam. Foug. 2: t.6, f.2 (1845); Sim, Ferns S. Afr. ed. 2: t.148 (1915); Tardieu in Humbert Fl. Madagasc., Polypod. 2: t.9, f.3–4 (1960).

Rhizome widely creeping, branched, up to 6 mm diam., phyllopodia up to 25 mm long, black to grey, aerophores strongly developed, rhizome densely set with golden-brown, scariose, lanceolate scales with numerous long filamentous outgrowths along their margins, variable in size, up to 12 × 2,5 mm; stipes approximate, firm, pale brown, black at base, shallowly sulcate ventrally, trophophyll stipe up to 150 mm long, sporophyll stipe usually longer than that of trophophyll, up to 180 mm long, few ovate scales with short, more irregular filamentous outgrowths along margin, confined to stipe base, up to 10 × 2,5 mm; trophophyll simple, entire, coriaceous, narrow-elliptic to elliptic, obtuse to longly decurrent at base, up to 320 × 70 mm, venation free, ventral and dorsal surface with small sclerified substellate to stellate scales, scales on ventral surface often confined to lamina base; spo-

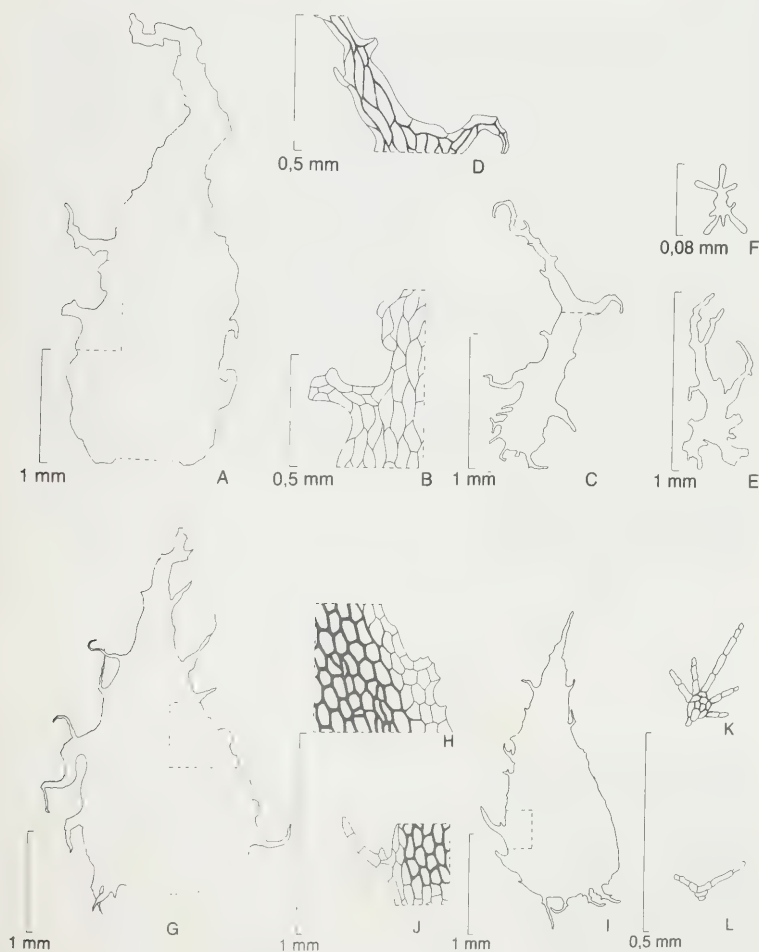


FIG. 11.

A-L. scales of *E. macropodium*, Roux 382 (NBG) and *E. angustatum*, Roux 773 (NBG). A-F, *E. macropodium*. A. rhizome scale; B. detail; C. stipe scale; D. detail; E and F. trophophyll scale from ventral surface. G-L, *E. angustatum*. G. rhizome scale; H. detail; I. stipe scale; J. detail; K and L. trophophyll scale from dorsal surface midrib.

rophyll simple, entire, coriaceous, narrow-lanceolate to narrow-elliptic, acute to obtuse or longly decurrent to base, midrib shallowly sulcate ventrally, up to  $270 \times 40$  mm, venation free, ventral surface glabrous, dorsal surface with few sclerified, stellate scales along midrib; sori acrostichoid but often incomplete at base, annulus large, 10–12 (12)-celled, spores rotund, sporoderm forming short and long, narrow to broad, reticulate ridges up to  $4 \mu\text{m}$  high, ridges and areas between with few spinules, variable in length, 27–30  $\mu\text{m}$  diam.

#### PHYTOGEOGRAPHY AND ECOLOGY

The distribution of *Elaphoglossum macropodium* is more or less restricted to the Eastern Transvaal escarpment, the Natal midlands and the coastal regions of the Transkei (Fig. 13).

Precipitation recorded within the range of distribution varies annually from 1 750 mm (Graskop–2430 DB), to 1 240 mm (Port St. Johns–3129 DA). Mists are frequent within this area throughout the year.

Habitats in which *E. macropodium* usually occur are deeply shaded, moist, evergreen riverine or mountain forests where the plants are lithophytes or low-level epiphytes which often form extensive stands. Exposed plants, which are not commonly found, are usually depauperate.

Hemicryptophyte (litho- or epiphytic). Fronds meso- xeromorphic, articulated. Seasonal pattern unknown. Effective vegetative propagation by widely creeping branched rhizome. Sexual reproduction unknown to the author.

#### PHENOTYPE VARIATION

Variation within *E. macropodium* is more or less restricted to frond size and scale density on the lamina surfaces. Plants growing in exposed conditions tend to have lamina scales more sparsely set. Plants from xeric conditions have rhizome scales which are entirely sclerified, smaller and with less filamentous outgrowths, often becoming subentire.

Reticulate veins were observed in the trophophyll but this is sporadic.

#### MATERIAL EXAMINED

TRANSVAAL—2430 (Pilgrims Rest): Mariepskop, Graskop (-DB), -/4/1946, Schweickerdt 1630 (NU); Klaserie waterfall, Mariepskop, 6/1/1960, v. d. Schyff 4927 (W); Fairyland, Graskop (-DD), 6/1/1979, Roux 382 (NBG).

NATAL—2731 (Louwsburg): Ngome Forest, Ngotshe Distr. (-CD), 10/2/1962, Tinley 730 (NU); Ngome Forest, Ngotshe, 16/7/1956, Schelpe 6229 (K). —3130 (Port Edward): Beacon Hill East, Port Shepstone (-AA), 1/1/1967, Strey 7244 (NH).

TRANSKEI—3129 (Port St. Johns): South facing cliff near airstrip (-DA), 24/4/1979, Roux 586 (NBG).



FIG. 12.  
*E. angustatum*, habit. Roux 773 (NBG).

4. *Elaphoglossum angustatum* (Schrad.) Hieron. in Bot. Jahrb. **46**: 404 (1911). Figs 11G–L and 12.

*Acrostichum angustatum* Schrad. in Gött. Gel. Anz.: 915 (1818). Type: Cap b. Sp., *Hesse s.n.* (GOET, holo.!).

*Olfersia angustata* (Schrad.) C. Presl, Tent. Pterid.: 234 (1836).

*Acrostichum conforme* Sw. var. *schraderii* Fée, Mém. Fam. Foug. **2**: 31 (1845). Type: as for *E. angustatum*.

*Elaphoglossum conforme* (Sw.) Schott var. *latifolium* Sim, Ferns S. Afr. ed. **2**: 286 (1915). Type: Inanda & Great Noodsberg, *Buchanan s.n.* (NH, lecto.!).

Rhizome widely creeping, branched, up to 8 mm diam., phyllopodia 3–7 mm long, black, aerophores small, rhizome densely set with pale brown, scariose, lanceolate scales with numerous filamentous outgrowths along the margin, up to  $9 \times 1,5$  mm; stipe approximate, terete, firm, pale brown to green, trophophyll stipe up to 310 mm long, sporophyll stipe usually longer than trophophyll stipe, up to 350 mm long, with few deciduous, scariose, amorphous scales with few filamentous outgrowths along their margins, up to  $3,5 \times 1,2$  mm; trophophyll simple, entire, firmly herbaceous, linear to narrow-elliptic, apex acute to obtuse, longly decurrent to base, up to  $300 \times 50$  mm, venation free, midrib shallowly sulcate ventrally, ventral surface with few minute pale brown, substellate to filiform scales becoming more frequent near base and along midrib; sporophyll simple, entire, firmly herbaceous, narrow-elliptic, apex often obtuse, longly decurrent to base, up to  $250 \times 20$  mm, venation free, midrib shallowly sulcate ventrally, ventral and dorsal surfaces with minute, pale brown, substellate to filiform scales along midrib; sori acrostichoid, annulus large, 12–13 (12)-celled; spore sporoderm with irregular, narrow, reticulate wings up to  $4 \mu\text{m}$  high, crests finely fimbriate, wings and areas between are papillate, papillae often form small units, otherwise relatively smooth,  $32\text{--}42 \mu\text{m}$  diam.

*Elaphoglossum angustatum* was not accepted as a valid taxon by numerous authors for many years. In most accounts (Fée, 1845; Moore, 1857; Christensen, 1905; Sim, 1892 and 1915) the taxon was referred to as a variety, form or even a synonym of *E. conforme*.

Pappe and Rawson (1858) followed Presl (1836) by referring the taxon to the genus *Olfersia*, Moore and Christensen bluntly placed *E. angustatum* as a form of *E. conforme* while Fée created a variety, var. *schraderii*, for the taxon.

Sim (1892) assigned material from Natal, collected by Buchanan and Wood, erroneously to the tropical American species *A. latifolium* Sw. However, in 1915, Sim realised this error and arbitrarily assigned the Natal speci-



men to a new var. *latifolium* under *E. conforme*, citing also a collection from Mt. Pene, Rhodesia (Zimbabwe).

Schelpé (1969) cited *E. conforme* var. *latifolium* Sim as a synonym of *E. macropodium*. The present author has however studied the Buchanan collection at Kew which has been cited by Schelpé as a syntype and has found it to be *E. angustatum*. The author also studied a Buchanan collection from Inanda and Great Noodsberg which is housed in the Natal Herbarium and he found that this too was a specimen of *E. angustatum*. The material in the Natal Herbarium, being made by the same collector from the same locality as was cited by Sim, is obviously the entire or part of the type collection.

The material from Mt. Pene has presumably either been lost or was not preserved as it could not be traced. The author therefore proposes the material in the Natal Herbarium as lectotype of *E. conforme* var. *latifolium*, and not the sheet at Kew which merely gives Natal as locality.

#### PHYTOGEOGRAPHY AND ECOLOGY

The distribution of *Elaphoglossum angustatum* is apparently confined to Table Mountain Sandstone and seems to be restricted to sheltered kloofs and ravines of the Cape mountains up to the Grootrivier (3323-CD). There is a distribution gap between the latter locality and the Natal coast. On Huntley's (748) specimen it is noted that the species grows on sandstone outcrops and only occurs on south-east facing areas at Port Edward (Fig. 13).

Over most of the range the species has been recorded from deeply shaded moist conditions such as cliffs, near waterfalls, on stream and river-banks as well as forest floors.

The climate over the range of *E. angustatum* is temperate and the species occurs well below the snowline. Rainfall varies from between 778 mm per annum at Knysna to 870 mm at Kranskop. Mists are frequent over the entire range of distribution.

Hemicryptophyte (terrestrial, litho- or epiphytic). Fronds meso- xeromorphic, articulated. Seasonal pattern irregular. Effective vegetative propagation by branched, creeping rhizome. Sporelings are also common on permanently moist mossy cliffs or boulders.

#### PHENOTYPE VARIATION

Extensive variation often occurs in frond size and shape. No influences can be identified which could cause such variation as it often occurs within a single population. A slight degree of variation in the density of scales on the lamina may also be distinguished.

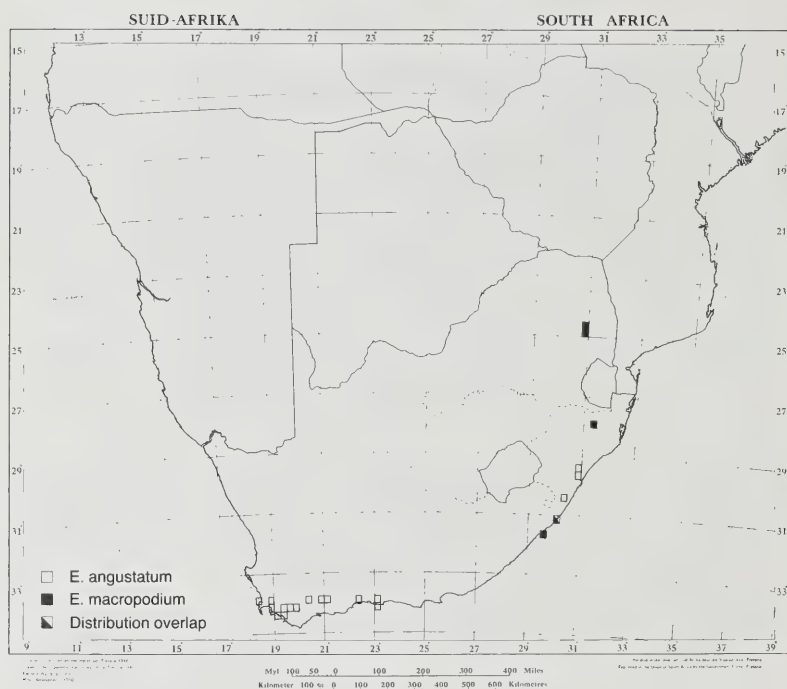


FIG. 13.  
Distribution map of *E. macropodium* and *E. angustatum*.

#### MATERIAL EXAMINED

NATAL—2930 (Pietermaritzburg): Inanda & Great Noodsberg (-BD/-DB), *Buchanan s.n.* (NH); Noodsberg, NH 26393 (NH).

—3030 (Port Shepstone): Emisdale, Umgaye flat, Alexandra Country (-AD), 20/2/1910, *Rudatis 608* (STE).

—3130 (Port Edward): Beacon Hill East (-AA), 8/2/1972, *Strey 10619* (NH); Izingolweni road, Port Edward, *Huntley 748* —top right and bottom left specimens only (BM, NU); Beacon Hill east, Port Shepstone, 1/1/1967, *Strey 7244* (K).

CAPE—3318 (Cape Town): Nursery Gorge, above Kirstenbosch (-CD), 5/12/1976, *Roux 76* (NBG); Table Mountain, —/2/1887, *Thode 27436*—two large specimens only (STE); Table Mountain, 2/6/1953, *Schelp 3898* (BM); Waterfall on Table Mountain, —/6/1847, *Prior s.n.* (K); Jonkershoek, second waterfall (-DD), 26/11/1942, *Rycroft 606* (NU); Stellenbosch, tweede waterval, 24/5/1958, *Steyn 12* (STE); Stellenbosch, tweede waterval, 24/5/1958, *Perold 9* (STE).

—3320 (Montagu): Swellendam Forest Reserve, Marloth Reserve (-CD), 15/1/1970,

- Kruger 1042* (STE); Grootvaders Bosch, Heidelberg (-DD), 3/12/1958, *Barker 8825* (NBG); Strawberry Hill, Langeberg, -/12/1954, *Stokoe s.n.* (SAM).  
 —3321 (Muiskraal): South-west of Aasvoëlkrantz, above Oudebosch (-CC), 7/6/1978, *Roux 281* (NBG).  
 —3322 (Oudtshoorn): George (-CD), *Holland s.n.* (NBG); Hoogekraalsrivier, -/1838, *Drège s.n.* (BM); Krakakow, George, -/11/1947, *sine coll.* (K).  
 —3323 (Willowmore): Deep Walls forest near Big Tree, Knysna (-CC), 3/10/1963, *Barker 9956* (NBG); Kleinbos, Buffelsnek, Knysna Div., 16/12/1953, *Schelpé 4315* (BM); Buffelsnek Forest Reserve, Knysna, 5/7/1960, *Schelpé 6553* (C); Knysna, *Britten s.n.* (GRA); Groot Rivier (-CD), 10/11/1951, *Taylor 3595* (NBG).  
 —3418 (Simonstown): W. bank of Steenbras River, at waterfalls, (-BB), 4/3/1934, *Acock 4939* (S); Harold Porter Botanic Garden, Betty's Bay (-BD), 21/8/1979, *Roux 708* (NBG); Disa Kloof, Betty's Bay, 6/3/1961, *Rycroft 2268* (NBG, STE); Hangklip Gorge, Caledon, 4/9/1942, *Compton 13535* (NBG); Harold Porter Botanic Garden, 13/5/1963, *Topper 111* (NBG); Kogelberg State Forest, Koedoebos, 24/11/1972, *Boucher 2043* (STE); Kogelberg Forest Reserve, 12/5/1969, *Boucher 315* (STE).  
 —3419 (Caledon): Zonder End (-AB), *Barnard 418* (SAM); In valley at Hermanus (-AC), -/10/1937, *Stander s.n.* (STE); Caledon (-AD), *Zeyher s.n.*—specimen on right (SAM); Rivier Sonder End mountains, Caledon Div. (-BA/-BB), -/6/1949, *Stokoe s.n.* (SAM); Kloof north of Riviersonderend (-BB), 14/6/1974, *Goldblatt 2058* (NBG).  
 —3423 (Knysna): Lilyvlei near Knysna (-AA), 7/12/1936, *Linneberg s.n.* (S); Concordia, Knysna, 29/6/1944, *Rycroft 647* (NU).  
 Without exact locality: NH 9746, 26622 (NH); *Barkly s.n.*, SAM 24976 (SAM); *Burchell* Cat Geog. Pl. Afr. Aust. 5851 (K); Cap, -/1845, *Drège s.n.* (G); Promontorium bonae Spei, *Gueinzus s.n.* (C); Cap bon. Sp., *Wolff s.n.* (C); Kap, *Zeyher s.n.* (S); Natal, *Wood s.n.* (S); e Cap b. Sp., *Wänman 35* (SBT); e Cap b. Sp., *Thunberg s.n.* (SBT); Cap b. Spei, *Roser s.n.*—except top central specimen (W); Natalia, *Gueinzus s.n.* (W); Baviaanskloof W 365246 (W); Cap b. Sp., *Ecklon s.n.* (W); Natal, *Buchanan s.n.* (K).

##### 5. *Elaphoglossum spathulatum* (Bory) Moore, Ind. Fil.: 14 (1857).

*Acrostichum spathulatum* Bory, Voy. Quatre Princ. Iles 1: 363, t.20, f.1 (1804). Type: Réunion, R. St. Denis, *M. Bory de St. Vincent s.n.* (P, holo.). **Fig. 14A–F.**

*Olfersia spathulata* (Bory) C. Presl. Tent. Pterid.: 233 (1836).

*Elaphoglossum ulugurense* Reimers in Notizbl. Bot. Gart. Berl. 12: 80 (1934). Type: Uluguru gebirge: NO., Neberwald, 14/5/1933, *Schlieben 3931* (B, holo.!; BM, iso.).

*Elaphoglossum spathulatum* (Bory) Moore var. *ulugurense* (Reimers) Schelpé in Jl S. Afr. Bot. 30(4): 197 (1964).

Icones: Presl, Rel. Haenk. 1: t.2, f.1 (1826); Fée, Mém. Fam. Foug. 2: t.14, f.3 (1845); Sim, Ferns S. Afr., ed. 2: t.150, f.1 (1915); Vareschi in Fl. Venez., *Helechos* 1(2): t.165 (1969).

Rhizome creeping, up to 2 mm diam., densely set with pale brown, scarious, narrow-lanceolate, entire to shallowly dentate scales, often with few filamentous outgrowths at base, variable in size, up to 2 × 0,5 mm; stipe approximate, terete, firm, pale brown to green, trophophyll stipe up to 36 mm

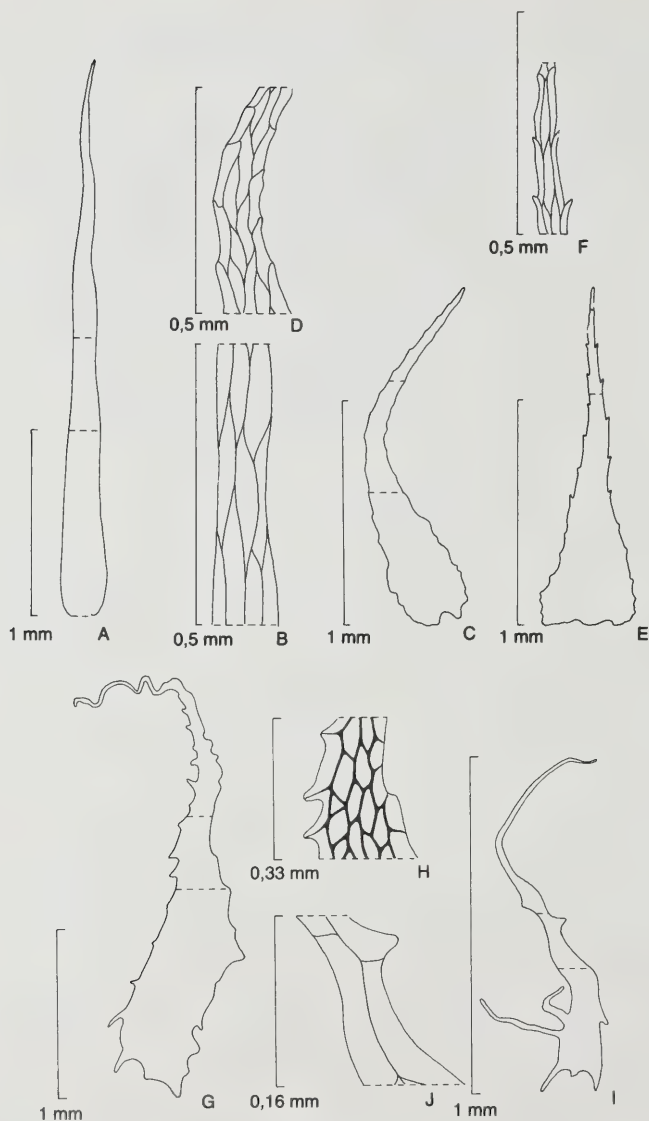


FIG. 14.

A–J, scales of *E. spathulatum*, Roux 970 (NBG) and *E. drakensbergense*, Roux 824 (NBG). A–F, *E. spathulatum*. A. rhizome scale; B. detail; C. stipe scale; D. detail; E. trophophyll scale from ventral surface; F. detail. G–J, *E. drakensbergense*. G. rhizome scale; H. detail; I. trophophyll scale from ventral surface; J. detail.

long, sporophyll stipe usually longer than that of the trophophyll, up to 60 mm long, densely set with scariose, narrow-lanceolate, entire to shallowly dentate scales with inrolled margins, variable in size, up to  $2 \times 0,3$  mm; trophophyll simple, entire, herbaceous, spathulate to elliptic, cuneate to longly decurrent at base, up to  $23 \times 12$  mm, venation free, ventral surface densely paleate with pale brown scariose, narrow-lanceolate, cordate, shallowly dentate scales with inrolled margins, up to  $2 \times 0,4$  mm, dorsal surface scales similar to those on ventral surface but fewer and smaller, up to  $1,5 \times 0,3$  mm; sporophyll simple, entire, firmly herbaceous with membranous margin, ovate to rotund, usually folded together along midrib, up to  $11 \times 10$  mm, venation free, ventral surface scales less frequent than those on trophophyll, lanceolate, shallowly dentate, base sclerified, up to  $2,5 \times 0,4$  mm, scales absent on dorsal surface; sori acrostichoid except for membranous margin of frond, annulus large, 11–12 (12)-celled; spores monolete, reniform to rotund, sporoderm with broad, low, reticulate ridges, except for a clearly defined straight central ridge, crests and areas between scabrous,  $45\text{--}52\text{ }\mu\text{m}$  diam.

*Acrostichum piloselloides* C. B. Presl (type from Peru) has been cited by several authors (Christensen, 1905; Schelpe, 1969; 1970; Vareschi, 1969) as a synonym of *E. spathulatum*. Fée (1845), however accepted the species as distinct, and his illustrations of the two are very different. [Presl described specimens attributed to both species in his *Reliquiae Haenkeanae* (1825). The specimen which he identified as *E. spathulatum*, from the Philippines, was probably *E. blumeum* var. *philippinense* Holttum, Flora Malesiana Ser. II, 1(4): 311 (1978); he saw no specimens from Réunion, as Luzon was the westward limit of Haenke's journey.] The present author has therefore deleted *E. piloselloides* as a synonym of *E. spathulatum*, but he has not studied Presl's type which is probably in one of the two herbaria at Prague (see Holttum's report of 1969 on Presl's types, in which *E. piloselloides*, being a tropical American species, is not mentioned).

#### PHYTOGEOGRAPHY AND ECOLOGY

*Elaphoglossum spathulatum* has a restricted distribution within the political boundaries of South Africa. The distribution is largely influenced by the geology, which has resulted in the much dissected topography of the Natal Drakensberg and the north-eastern corner of the Orange Free State. Cave Sandstone, which is overtopped by a layer of basalt several thousand metres thick, forms the prominent geological formation (Fig. 15).

Precipitation at Witsieshoek (alt. 1 699 m), measures 811 mm per annum. Higher up the rainfall will presumably be much more. Several sn...



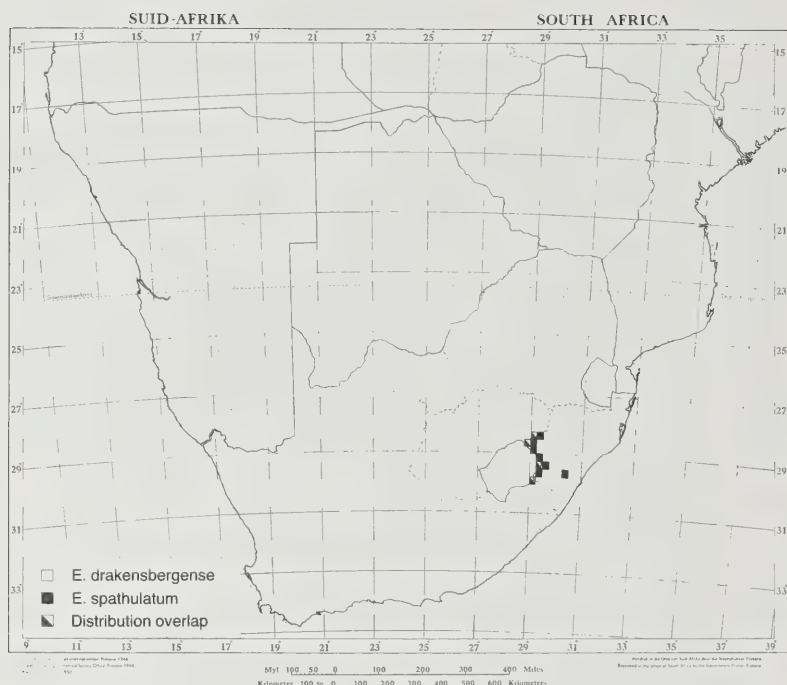


FIG. 15.  
Distribution map of *E. spathulatum* and *E. drakensbergense*.

falls occur annually between June and September, but more so at altitudes above 2 100–2 500 m. Mists are frequent throughout the year.

The habitat with which *E. spathulatum* is usually associated is deeply shaded conditions in seasonally wet evergreen riverine forests.

Hemicyptophyte (geo- or lithophytic). Mesophilous, fronds meso- xeromorphic, articulated. Seasonal pattern irregular. Vegetative propagation by short, branched creeping rhizome. More effective propagation however takes place through spores. Sporelings are commonly found with mature plants on mossy rock faces.

#### PHENOTYPE VARIATION

Except for a slight degree of variation in frond size and shape, no other form of variation was observed within the species.

## MATERIAL EXAMINED

ORANGE FREE STATE—2829 (Harrismith): Farm Bosch Hoek, east of Manzenya (AD), 12/12/1980, *Roux* 885 (NBG); Van Reenen, 2/3/1895, *Schlechter* 6919 (G, K); Farm Klavervlei (-CA), 11/12/1980, *Roux* 882 (NBG).

NATAL—2828 (Bethlehem): Royal Natal National Park, gorge (-DB), 5/5/1967, *Strey* 7476 (NH); Near Sunday Falls, Royal Natal National Park area, 6/11/1946, *Schelp* 1814 (NH); Duivels Hoek, Mont-aux-Sources area, 6/4/1946, *Schelp* 1462 (NU).

—2829 (Harrismith): Van Reenen's Pass (-AD), -/2/1908, *Thode* 4184 (STE); Oliviershoek Pass (-CA), -/2/1900, *Thode* 5232 (STE); Little Switzerland, Oliviershoek, 16/3/1981, *Roux* 970 (NBG); Rainbow Gorge, Cathedral Peak area (-CC), 14/4/1978, *Cowan* 70 (NU); nKdhlahla Forest, Cathedral Peak area, -/2/1943, *Schelp* p. 21 (NU); Cathedral Peak area, -/7/1944, *Esterhuysen* 10208 (NBG); Rainbow Gorge, Cathedral Peak area, 18/4/1978, *Cowan* 92 (NU); Umlambanja Forest, Cathedral area, -/1944, *Schelp* 391 (NU); Between Camel and Pyramid, Cathedral area, -/7/1944, *Schelp* 678 (NU).

—2929 (Underberg): Injasuti area, Natal (-AB), *Esterhuysen* 26046 (K); Cathkin Peak Ravine, *Strey* 7812 (NH); Giants Castle, Natal, -/1906, *Sim* s.n. (NU); Caves Forest, Giants Castle (-BC), 12/1/1979, *Roux* 421 (NBG); Upper Polela Cave, Cobham Forestry Reserve (-CB), 15/2/1979, *Hilliard & Burt* 12607 (NU).

—2930 (Pietermaritzburg): Zwartkop, Pietermaritzburg Distr. (-CB), -/1/1916, *Carnegie* s.n. (NU).

Without exact locality: NH 9747—small specimen on right (NH); *Barkly* s.n., SAM 24993 (SAM); Natal, *Buchanan* s.n. (K); Cape of Good Hope, -/1862, *Cooper* s.n. (K); Natal, -/1868, *McKen* s.n. (K); Natal, *Barkly* 141 (GRA).

6. *Elaphoglossum drakensbergense* Schelpe in Jl S. Afr. Bot. 34(4): 237 (1968). Type: Natal, Escort Distr., Drakensberg, Injasuti area. *Esterhuysen* 26052 (BOL, holo.; BM, C, K, iso.). Figs 14G–J and 16.

Rhizome creeping, up to 2.5 mm diam., phyllopodia up to 4 mm long, dark brown to black, lacking aerophores, densely set with pale to dark brown, scariose, narrow-lanceolate scales up to  $5 \times 0.5$  mm; stipe approximate, terete, firm, trophophyll stipe up to 78 mm long, sporophyll stipe usually longer than that of trophophyll, up to 92 mm long, densely set with pale brown, scariose, narrow-lanceolate scales which are shallowly dentate or with a few long filiform outgrowths along the margin, up to  $3 \times 0.3$  mm; trophophyll simple, entire, herbaceous, broad-elliptic to ovate or spatulate, up to  $60 \times 13$  mm, venation free, ventral surface densely set with pale brown, scariose, lanceolate attenuate scales, entire or shallowly dentate, peltate scales varying much in size, up to  $1.5 \times 0.2$  mm, dorsal surface glandular, with scales similar to that of ventral surface along midrib, otherwise scaleless; sporophyll simple, entire, herbaceous, narrow-elliptic to ovate, up to  $30 \times 10$  mm, ventral surface densely set with pale brown, scariose lanceolate attenuate scales with few long filiform outgrowths along margin, peltate scales varying much in size, dorsal surface with few scales along midrib similar to that on ventral surface; sori acrostichoid, annulus large, 12–14 (12)-celled, spores monoletate, reniform to rotund, sporoderm with low, sho-

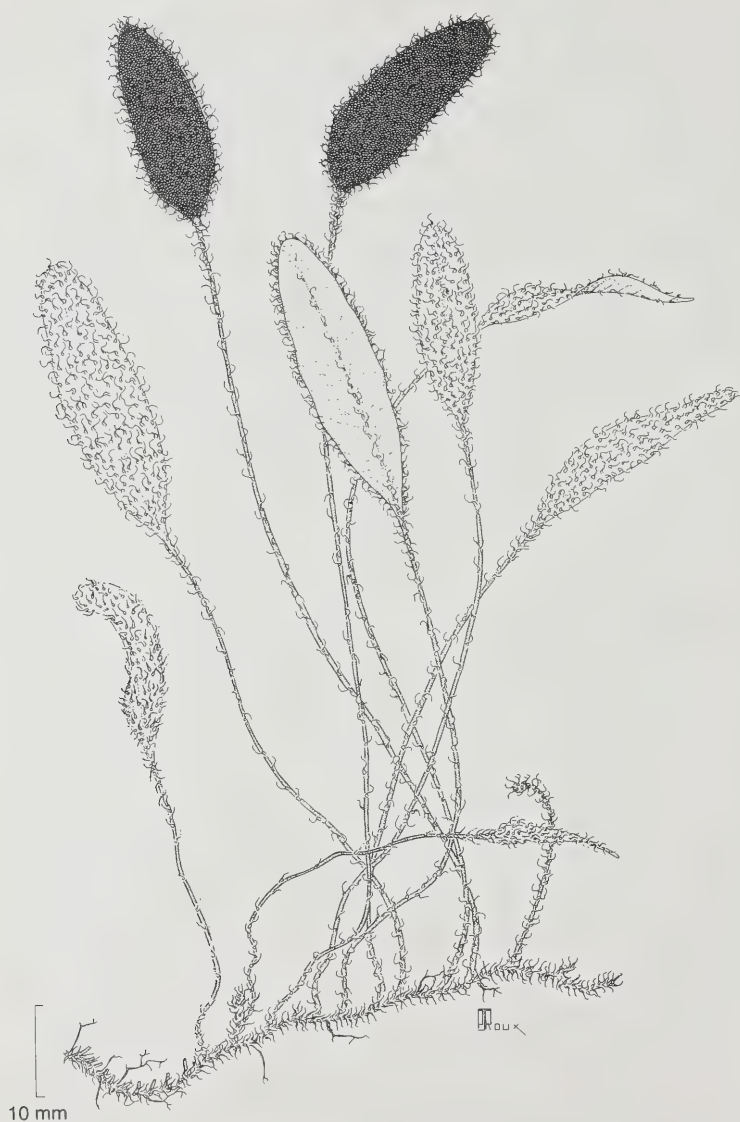


FIG. 16.  
*E. drakensbergense*, habit, scales not exhibiting detail. Roux 824 (NBG).

or long reticulate ridges, except for a clearly defined straight central ridge, crests and areas between spinulose, variable in size and density, 45–50  $\mu\text{m}$  diam.

#### PHYTOGEOGRAPHY AND ECOLOGY

*Elaphoglossum drakensbergense* is restricted to the Natal Drakensberg and the mountainous north-eastern corner of the Orange Free State.

Cave Sandstone and basalt form the major geological formations within the range of distribution which is largely restricted to altitudes between 2 100 and 3 000 m (Fig. 15).

Precipitation at Cathedral Peak measures 1 262 mm per annum which is reduced to a mere 777 mm per annum on Platberg, the most northern known limit of its distribution. Regular snowfalls occur annually between June and September. Mists are also frequent throughout the year.

*E. drakensbergense* occurs in relatively dry as well as exposed conditions. Collections have been made from dryish rock overhangs, and rock crevices, as well as low cliffs among grass tussocks.

Hemicryptophyte (geo- or lithophytic). Meso- xerophilous, fronds meso-xeromorphic, poikilonhydrous, articulated. Seasonal pattern irregular. Effective vegetative propagation by creeping rhizome.

#### PHENOTYPE VARIATION

Variation is more or less restricted to frond size. Scales on the dorsal surface of the trophophyll are usually restricted to the midrib but it was noticed that scales, although few, also occur on the lamina. Such scales usually occur close to the midrib and the margin.

The glands on the dorsal surface of the trophophyll are more conspicuous in young living material. However, this character is not always lost in herbarium specimens.

#### MATERIAL EXAMINED

ORANGE FREE STATE—2828 (Bethlehem): In cave on south-east facing cliff near Sentinel (-DB), 14/4/1981, *Roux 971* (NBG).

—2829 (Harrismith): On upper plateau of Platberg (-AC), 22/1/1981, *Roux 824* (NBG); Donkey's Pass, Platberg, 28/6/1980, *Roux 800* (NBG).

NATAL—2929 (Underberg): Langalibalele Pass, Giants Castle National Reserve (-AD), 21/4/1979, *Cowan 164* (NU); Mooi River, Natal, *Bell s.n.* (K); Bushman's Nek Pass, Underberg Dist., (-CC), 7/7/1979, *Cowan 165* (NU); Thamaltea Cave, Bushman's Nek, Underberg Dist., 6.2.1976, *Hilliard & Burt 8997* (NU).

Without exact locality: NH 9747—large specimen on left (NH).

#### 7. *Elaphoglossum aubertii* (Desv.) Moore, Ind. Fil.: 5 (1857). Fig. 17A–F.

*Acrostichum aubertii* Desv. in Mag. Ges. Naturf. Berl. 5: 309 (1811).  
Type: In Insula Borboniae. *Aubert du Petit-Thouars s.n.* (P, holo.!).

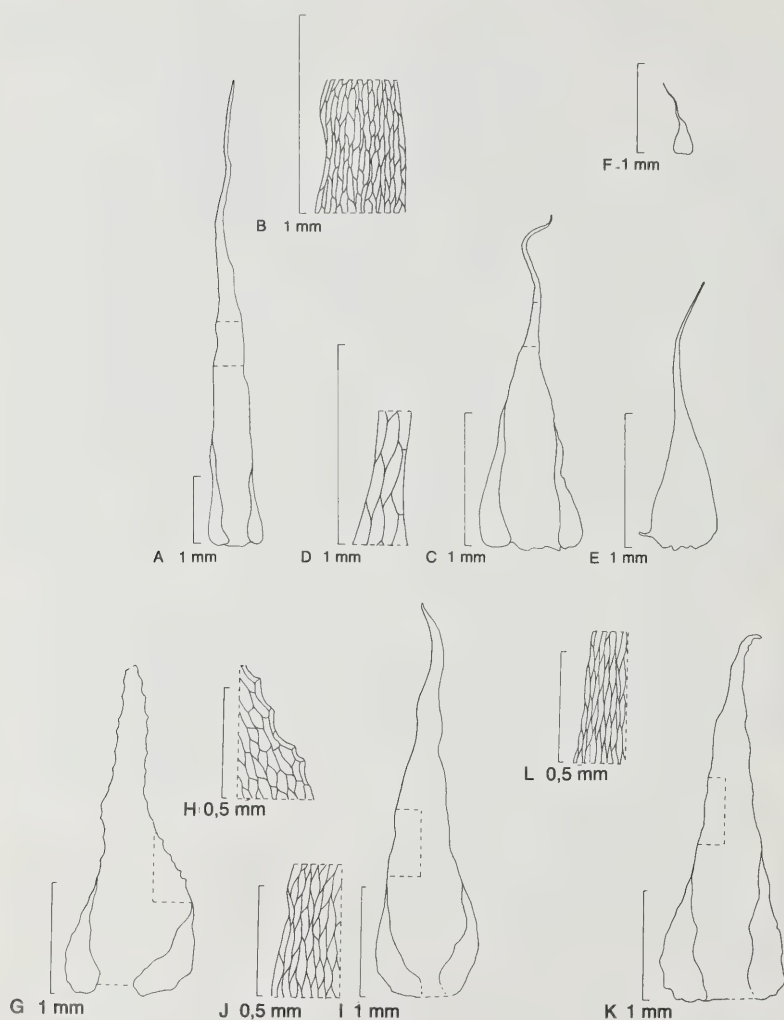


FIG. 17.

A–L, scales of *E. aubertii*, Roux 988 (NBG) and *E. hybridum*, SAM 24988 (SAM). A–F, *E. aubertii*. A. rhizome scale; B. detail; C. trophophyll stipe scale; D. detail; E. midrib scale from dorsal surface of trophophyll; F. lamina scale from dorsal surface of trophophyll. G–L, *E. hybridum*. G. rhizome scale; H. detail; I. trophophyll stipe scale; J. detail; K. trophophyll lamina scale; L. detail.



*Acrostichum lineare* Fée, Mém. Fam. Foug. 2: 47, t.15, f.2 (1845). Type: Mont d'Organi, Brasil, Gardner 98 (G, holo.!, BM, K, iso.!).

*Elaphoglossum lineare* (Fée) Moore, Ind. Fil.: 11 (1857).

*Acrostichum boivinii* Mett. ex Kuhn, Fil. Afr.: 43 (1868). Type: Ins. Mauritii, Boivin s.n. (W, holo.!).

Icones: Fée, Mém. Fam. Foug. 2: t.18, f.1 (1845); Sim, Ferns S. Afr., ed. 2: t.152 (1915); Tardieu in Humbert Fl. Madagasc., Polypod. 2: t.14, f.4-7 (1960); Tardieu in Aubréville, Fl. Cameroun 3: t.47, f.5-8 (1964).

Rhizome short; creeping, up to 6 mm diam., phyllopodia up to 3 mm long, black, aerophores narrow, forming a wing which often extends beyond the point of articulation, rhizome densely set with dark brown lanceolate scales with few filamentous outgrowths at the base, variable in size, up to  $5 \times 0,8$  mm; stipes caespitose, firm, shallowly sulcate ventrally, trophophyll stipe up to 150 mm long, sporophyll stipe usually longer than that of the trophophyll, up to 250 mm long, densely set with pale brown scarioso lanceolate to narrow-lanceolate entire scales, variable in size, often reduced in number to the base of lamina, up to  $4 \times 0,8$  mm; trophophyll simple, entire to shallowly crenulate, herbaceous, linear, attenuate to apex, longly decurrent to cuneate at base, midrib shallowly sulcate ventrally, up to  $345 \times 20$  mm, venation free, ending in hydathodes near margin, ventral surface with numerous lanceolate to narrow-lanceolate scales, margins inrolled, variable in size, up to  $1,2 \times 0,4$  mm, dorsal surface with stellate to lanceolate scales with filamentous outgrowths at base, margins inrolled, up to  $6 \times 0,4$  mm, frequent; sporophyll simple, entire, herbaceous, lanceolate to linear, acute, base often oblique, midrib shallowly sulcate ventrally, up to  $95 \times 20$  mm, venation free not ending in hydathodes, ventral surface glabrous; sori wholly acrostichoid, annulus large, 12-celled.

The frond scales of the type of *Acrostichum lineare* Fée are slightly more sclerified and the fronds much narrower than the condition usually found in *E. aubertii*. The stipes of the sporophylls tend to be very glabrous. A few scales however do occur here. Species status cannot be given to a taxon which varies in such a slight degree from *E. aubertii*.

#### PHYTOGEOGRAPHY AND ECOLOGY

The distribution of *Elaphoglossum aubertii* in South Africa is restricted to the Eastern Transvaal escarpment and the Natal midlands (Fig. 18).

Rainfall, although predominantly seasonal (October-April), may occur throughout the year. At Graskop the annual precipitation measures 1 340 mm while at Pietermaritzburg it measures 1 176 mm. Dense mists are frequent throughout the year.

*E. aubertii* is confined to deeply shaded, moist evergreen riverine

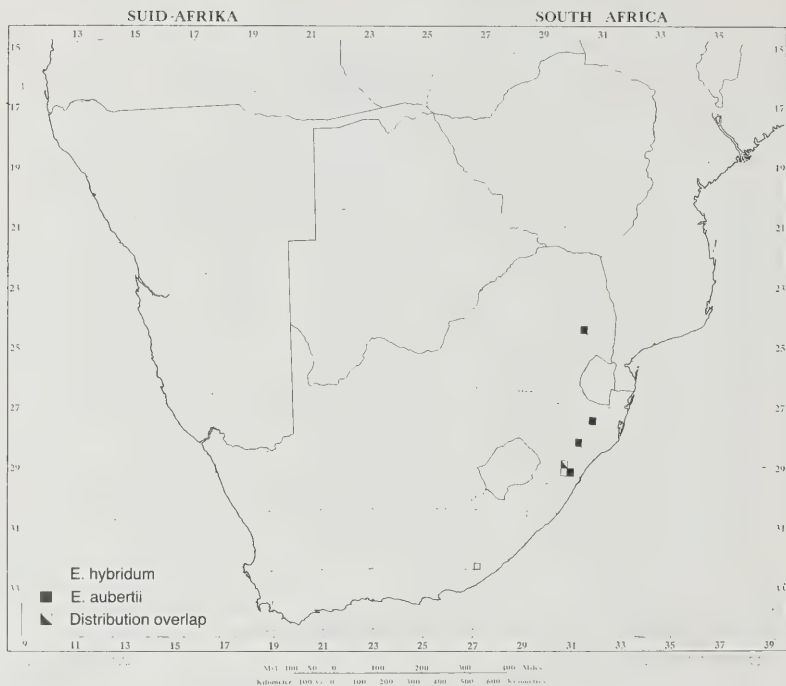


FIG. 18.  
Distribution map of *E. aubertii* and *E. hybridum*.

mountain forests. Plants occur singly or as a few individuals grouped together on damp mossy boulders near the water.

Hemicryptophyte (lithophytic). Fronds mesomorphic, articulated, seasonal pattern apparently irregular. Sporophylls collected in February, March, July and December. Propagation by branching rhizome. Sexual propagation was not observed by the author.

#### PHENOTYPE VARIATION

Variation of significance in *E. aubertii* is more or less restricted to frond size and shape.

#### MATERIAL EXAMINED

TRANSVAAL—2430 (Pilgrims Rest): Fairyland, Graskop (-DD), 6/1/1979, Roux 381 (NBG).

NATAL—2731 (Louwsburg): Ngome forest, Zululand (-CD), 23/3/1952, *Johnstone* 613 (NU).

—2830 (Dundee): Nkandhla, Qudeni Forest (-DB), 17/7/1956, *Schelte* 6262 (BM); Qudeni, Zululand, 15/2/1945, *Clarkson* 72 (NU); Qudeni, 15/2/1945, *Fisher* 814 (BM, NH); Qudeni, Zululand, 15/2/1945, *Allop* 739 (NU).

—2930 (Pietermaritzburg): "Branholme", Karkloof (-AD), -/5/1951, *Nixon* K. 136 (NH); Ehlatini Karkloof, 19/12/1965, *Moll* 2885 (NU); Karkloof forest, Lions River Distr., -/7/1961, *Farquharson* s.n. (NU); Karkloof, *Buchanan* s.n. (NH); Town Bush Valley, Pietermaritzburg (-CB), -/3/1944, *Schelte* s.n. (NU); Pietermaritzburg, *Guthrie* s.n. (SAM); Umlaas Natalensium (-DA), *Wood* s.n. (SAM).

Without exact locality: *Barkly* s.n. SAM 24991 (SAM); NH 9749, 26624 (NH); STE 27435 (STE); Zululand, *Rawson* 2994 (BM); Zululand, -/1864, *Gerrard* 1565 (K); Natal, *Barkly* 140 (GRA).

8. *Elaphoglossum hybridum* (Bory) Brack., U.S. Expl. Exped. 16: 69 (1854). Fig. 17G-L.

*Acrostichum hybridum* Bory, Voy. Quatre Princ. Iles 3: 95 (1804). Type: Réunion, Caverne Le Gentil, *M. Bory de St. Vincent* s.n. (P, holo.).

*Acrostichum ciliatum* Desv. in Mag. Ges. Naturf. Berl. 5: 310 (1811). Type: Réunion, *Commerson* s.n. in Herb. Jussieu (P, holo.).

*Acrostichum ciliare* Carm. in Trans. Linn. Soc. Lond. 12: 510 (1818) non Thouars (1804). Type: Tristan da Cunha, *Carmichael* s.n. (K, holo.).

*Acrostichum tricholepis* Bak. in Jl. of Bot. 29: 5 (1891). Type: Madagascar, Bé Kilus Mountains, *Last* s.n. (K, holo.).

*Elaphoglossum tricholepis* (Bak.) C. Chr., Ind. Fil.: 317 (1905).

*Acrostichum hybridum* (Bory) Brack. var. *vulcani* Fée, Mém. Fam. Foug. 2: 41, t.9, f.3 (1845). Type: Habitat in Borbonia, *Lepervanché* s.n. (P, holo.).

*Elaphoglossum hybridum* (Bory) Brack. var. *cuneatum* Bonap. in Not. Pterid. 14: 419 (1923). Type: De Nioumbadjou, Iles Comores, *Humbert* s.n. (P, holo.).

Icones: Fée, Mém. Fam. Foug. 2: t.9, f.3-4 (1845); Sim, Ferns S. Afr., ed. 2: t.151, f.1a (1915); Tardieu in Aubréville, Fl. Cameroun 3: t.47, f.1-4 (1964).

Rhizome short, creeping, up to 7 mm diam., densely set with dark brown sclerified, narrow-lanceolate to cordate, entire or shallowly crenate scales, often with few filiform filamentous outgrowths near base, up to  $3 \times 0.5$  mm; stipe caespitose, firm, pale brown shallowly sulcate ventrally, trophophyll stipe up to 170 mm long, sporophyll stipe usually longer than that of trophophyll, up to 235 mm long; sclerified, narrow-lanceolate entire scales with in-rolled margins frequent along the stipe of the trophophyll, up to  $4 \times 0.3$  mm; trophophyll simple, entire to shallowly undulate, herbaceous, broad to narrow-lanceolate or linear-acuminate, base cuneate to obtuse, up to  $210 \times 50$  mm, venation free, often reticulate, ventral surface with sclerified, entire, narrow-lanceolate and minute stellate scales, up to 0.1 mm diam., narrow-

lanceolate scales more commonly confined to midrib of ventral and dorsal surfaces, continuous along margin, stellate scales absent on dorsal surface; sporophyll simple, entire, herbaceous, lanceolate, base obtuse to acute, up to  $100 \times 20$  mm, venation reticulate, ventral and dorsal surfaces with few narrow-lanceolate, entire, sclerified scales along midrib; sori acrostichoid except for membranous margin, annulus cells small, 12-celled.

The type material of *E. tricholepis* is a mixed collection. The smaller specimen on the sheet appears to be *E. phanerophlebium*.

A label in the hand of Lepervanché which is attached to the type sheet of *A. hybridum* var. *vulcani* indicates that he was unable to determine the plant positively due to a lack of sufficient material in his herbarium. He further wrote that if the plant was distinct he would like to call it *vulcani* as it was collected at a high altitude on the exposed inner basalt cliff of the volcano on Réunion. The epithet *vulcani* was published with varietal rank by Fée, who attributed it to Lepervanché; the specimen is however only a depauperate form of *E. hybridum* (Fig. 19).



FIG. 19.

Holotype of *E. hybridum* var. *vulcani* Fée in the Museum of Natural History, Paris.

## MATERIAL EXAMINED

NATAL—2930 (Pietermaritzburg): Karkloof (-AD), *Brown s.n.*, *Wylie s.n.*, NH 7424, *Buchanan s.n.*, NH 26737 (NH); Buccleuch, Natal, -/1914, *Sim s.n.* (GRA); Hilton Road, Natal (-CB), -/4/1946, *Slinger 48* (NH).

CAPE—3227 (Stutterheim): Peri, prope Kingwilliamstown (-CC), -/3/1892, *Sim s.n.* (G, K, W).

Without exact locality: NH 9743, 26623 (NH); In humidis rupestribus montis Drakensberg pone Tenam Natalensium, *Buchanan s.n.* (SAM); *Barkly s.n.*, SAM 24988 (SAM); Natal, *Buchanan 134* (K); Drakensberg, Natal, *Bell s.n.* (K); Natal, *McKen s.n.* (K); Natal, *Rehman s.n.* (P).

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My sincerest thanks also goes to Prof. Holttum for critical comments and for drawing my attention to literature which otherwise would have been overlooked.

Lastly to Dr. D. Crawford and Mr. D. Gernecke of the Electron Microscope Unit at the University of Cape Town who most kindly did the scanning of the illustrated spores.

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SHORT NOTE

A NEW COMBINATION IN *LACHNAEA* L. (THYMELAEACEAE)

P. BOND

(Compton Herbarium, Kirstenbosch, Private Bag X7, Claremont 7735, R.S.A.)

In C. H. Wright's revision of the genus *Passerina* (*Flora Capensis* 5(2): 11 1915), he cites Bodkin Herb. Bolus 9086 as the type of *P. laniflora* C. H. Wright.

When D. Thoday revised the genus again he noted, "on the other hand *P. laniflora* must be excluded as the type specimen is a *Lachnaea*" (*Kew Bull.* 1923: 149). However, neither Thoday nor any other person appears to have made the new combination.

I agree with Thoday's remarks, as scales are present at the base of the filaments, the presence of which removes *P. laniflora* from the genus *Passerina*. I therefore propose the new combination *Lachnaea laniflora* (C. H. Wright) Bond.

***Lachnaea laniflora* (C. H. Wright) Bond, comb. nov.**

*Passerina laniflora* C. H. Wright in *Flora Capensis* 5(2): 11 (1915)—Basionym. Type: Clanwilliam Div., Cedarberg Range, Sneeuwkop. 4500', *Bodkin* in Herb. Bolus 9086 (BOL!).

SELECTED SPECIMENS EXAMINED

CAPE—3218 (Clanwilliam): Langberg, Clanwilliam, (-BA), 6200', 15/12/41, *Compton* 12745 (NBG).

—3219 (Wuppertal): Pilaarsberg north of Pakhuis Pass, Clanwilliam (-AA), 3000 ft., *Kerfoot* K 5913 (NBG).

—3319 (Worcester): Great Winterhoek, Tulbagh (-AA), c 6000 ft., *Phillips* 1668 (SAM); Skurfdebergen near Ceres (-AB), 4800 ft., *H. Bolus* 1355 (BOL, SAM); Elandsbloof south slope (-AC), 4000–5000 ft., *E. Esterhuysen* 3304 (BOL, NBG).

*Lachnaea laniflora* is a distinctive species perhaps nearest to *L. passerinoides* N.E. Br., but differing in the longer leaves and heads with more than two flowers, and in occupying upper to high altitude slopes in the Cedarberg, Tulbagh and Worcester mountains.



## BOOK REVIEWS

**AIR POLLUTION AND FORESTS: INTERACTIONS BETWEEN AIR CONTAMINANTS AND FOREST ECOSYSTEMS**, by W. H. Smith, with pp. xv + 379 and 60 figures. ISBN 3-540-90501-4. Berlin, Heidelberg, New York: Springer-Verlag, 1981. SPRINGER SERIES ON ENVIRONMENTAL MANAGEMENT. DM 64, approx. US \$ 30,50.

An understanding of the influence of the ever-increasing variety of air contaminants on the many components and processes of the forest is essential to our appreciation of the complex interactions between air pollutants and forest ecosystems. W. H. Smith presents a comprehensive documentation and review of research regarding these interactions.

In this informative book, the most significant relationships between forests and air pollution are highlighted for low, intermediate and high pollutant dose conditions. On this basis of dosage, a concept first proposed by the author in 1974, three classes of interactions are distinguished: Class I, Class II and Class III. These three classes provide the three sections of the text, covering (I) the function of forests as both sources and sinks for air pollutants, (II) the stresses caused to forest processes in a subtle manner, and (III) the dramatic influences on forest ecosystems.

Starting from the introductory pages, the reader is presented with a wealth of information which is clear, concise and interesting. This publication is also orderly: definitions are given for the terms, air pollution and ecosystem, before one reaches page three, by which stage primary and secondary air quality standards (for the United States) have been detailed and the range of materials which pollute the troposphere tabulated.

The role of forests is discussed with regard to the major element cycles: carbon, sulphur and nitrogen. Traditional models are reviewed together with new hypotheses. Estimates of global nutrients budgets however, are incomplete, and the author warns that predictions must be treated with caution.

Forests are known to be important sources of volatile hydrocarbons and particulates. Forest fires too, contribute to the pollutant load of the atmosphere.

The sink function of forests is detailed (60 pages) and concerns both the soil component and vegetation of forest systems. Trace elements, especially lead in roadside ecosystems, are important contaminants; other significant particulates include pollen and dusts. Gaseous pollutants such as carbon monoxide and sulphur dioxide can be transferred from the atmosphere to the soil by microbial mechanisms, while uptake of sulphur dioxide and oxidants by vegetation involves air flow and diffusion processes.

Ample evidence is given in support of the hypotheses that forest systems are important sources and sinks of air contaminants under conditions of low pollution dosage (Class I interactions). Additionally, consequences of these functions are assessed.

Class II relationships (intermediate doses of air pollutants) are primarily based on extrapolation from controlled laboratory and greenhouse experiments. The signifi-

ificance of Class II interactions is enormous, for direct or indirect physiological changes occur in individuals of the ecosystem which, in turn, may be severely affected. As Class II interactions may occur at pollution dosages approximating present ambient levels (in temperate forest areas), these relationships must be considered to be of great importance.

In 189 pages of text, figures, tables and references, evidence is presented of alterations in forest tree reproduction, forest nutrient cycling, tree metabolism, susceptibility to disease and insect pests, and symptomatic foliar injury caused by a range of air contaminants. Aspects covered in this section include pollen germination, organic matter decomposition, acid precipitation and leaching, nitrogen fixation, photosynthesis, phytophagous insects, plant pathogens, and acute foliar disease.

Resultant ecosystem impacts would be shown as reduced growth and thus, reduced biomass. Differential tolerance to air pollutants at the species level may be reflected at the ecosystem level as sustained alteration of reproductive potential, or competitive advantage of one species, leading ultimately to changes in succession and species composition of the community. In assessing the importance of these ecosystem changes, the author, of the School of Forestry and Environmental Studies at Yale University, calls for the establishment of comprehensive investigations to systematically examine Class II interactions in forest ecosystems subject to air pollution stress.

Class III relationships have been documented directly in the field since high pollutant dosages do occur in temperate forest regions adjacent to industrial, power generating or urban establishments. Extensive injury to vegetation may be caused by high pollution loads and is characterised by severe morbidity and mortality: trees may be badly injured or killed.

A number of examples of significant pollutant damage are given for air pollution episodes involving sulphur dioxide and fluorides. Knowledge is limited however, regarding the influence of oxidants on forest systems. Impact on ecosystems generally is acute and results in changes in species composition, reduced biomass, increased erodibility, and forest simplification. Although Class III interactions are the most dramatic of all responses, the actual forest areas involved are less extensive than in the Class I and Class II interactions.

The relative importance of specific air pollutants to forest ecosystems is discussed in the final chapter, with comments on the anticipated trends in emissions from anthropogenic sources over the next decade. The author predicts (for the United States) that increases will occur in emissions of carbon dioxide, sulphur dioxide, nitrogen oxides and particulates. He concludes that air pollution "has the potential to cause significant reductions in forest productivity and shifts in species composition in numerous areas throughout the temperate zone".

In presenting this review of the research involving air pollution and forests, W. H. Smith has produced an authoritative book of remarkable thoroughness. Concepts and hypotheses are clearly stated and the relevant authors cited: the reference section at the end of *each* chapter provides an outstanding selection of literature sources. Useful tabulations appear liberally throughout the text and 60 figures annotate the 379 pages. Typographically the text is accurate and visually well designed.

A criticism can be directed at the Index which is only just adequate; however, together with the very detailed listing of chapter contents given at the beginning of the book, one can readily locate the desired subject. Although the documentation is specifically intended to deal with forest ecosystems, nevertheless it is surprising that reference is not made to the extensive work carried out on lichens as indicators of air pollution.

Data detailed in this book relate to the temperate latitudes of the Northern Hemisphere. No South African species are mentioned; however, the research re-



viewed provides an invaluable base for interpreting the complex relationships between air pollutants and forest ecosystems in other regions.

This book is not intended for the layman, but is one in a series to be published by Springer-Verlag, "dedicated to serving the growing community of scholars and practitioners concerned with the principles and applications of environmental management". *Air Pollution and Forests* can be highly recommended to all persons involved in environmental matters, either from the aspect of air pollution, agriculture, afforestation, or management and function of terrestrial ecosystems.

E. R. ASHTON

PLANT SCIENCE: AN INTRODUCTION TO WORLD CROPS, edited by J. Janick, R. W. Schery, F. W. Woods and V. W. Ruttan, with pp. 868 and 520 figures. 3rd ed. ISBN 0-7167-1261-X. San Francisco: W. H. Freeman, 1981. Board £15.60.

Earth is a planet dominated by plants which serve, not only the human race but the entire living world, for many of its needs. An adequate food supply, both for domestic use and for export to less fortunate countries, remains of paramount importance. Greater and more intensive production of food and many other plant products must inevitably rate as priority number one in all civilised countries. Increasing knowledge of the three necessities of life—food, clothing and shelter—and the many other uses of plant products cannot fail to broaden one's outlook.

This book, the third edition, was written to give students the scientific, technological and economic foundations of world crop production. The sciences dealing with plants and the technology and economics of crop production and marketing have become irrevocably entwined. Each contributes relevance and meaning to the other. Although the text was planned for use primarily as an introductory, university-level course in plant science, crop science or economic botany, it is also highly recommended for use by anybody interested in this fascinating subject.

Part One, *Plants and People*, introduces the relationship between crops and civilisation in both historical and biological terms.

Part Two, *Nature of Crop Plants*, is a formal presentation of plant relationships, structure and development.

Part Three, *Plant Environment*, is an introduction to the ecology of crop plants.

Part Four, *Strategy of Crop Production*, features technological aspects of agricultural practices.

Part Five, *Industry of Plant Agriculture*, surveys individual crop species.

Finally Part Six, *The Marketplace*, explores the relation between crops and the economic community.

The authors must be congratulated on an excellent book, well illustrated and with a wide range of interesting and modern facts—a welcome addition to our literature in this field.

Any person or university seriously interested in varying aspects of Economic Botany, should add this volume to their bookshelves.

K. J. PIENAAR

MORPHOLOGIE DER BLÜTEN UND DER BLÜTENSTÄNDE, by F. Weberling, with pp. 391 and 193 figures. ISBN 3-8001-3426-8. Stuttgart: Eugen Ulmer, 1981. DM 108.

This immaculately produced book has clear illustrations some of which are photographs, others black and white diagrams and line drawings. Twenty pages of references together with extensive indices to plant names and subjects (including terminology) contribute to a useful reference book.

The layout would suit lecturers for graduate courses in the morphology and development of flowers, inflorescences and floral biology; the main sections into which the book has been divided. It will be equally useful as a reference to plant morphology.

1. *Morphology of Flowers*: The wide scope ranges from floral diagrams to bud initiation, floral axes, as well as the histogenesis and morphology of individual floral parts including structures such as the floral cup and hypanthium. Many modifications and specialisations of floral parts, such as polyandric androecia, petaloid staminodes, placentations, false septa and various types of nectaries, are just a few of the diverse phenomena discussed. The whole book is restricted to factual data and currently accepted concepts and does not enter into controversial hypotheses on, for example, the evolutionary origin of particular organs.

2. *Morphology of Inflorescences*: The definitions and delimitations of inflorescences immediately indicate that the author employed only Troll's system of classifying inflorescences, which despite being largely a new approach includes many conventional concepts. The uninitiated might find this at first perplexing but will soon realise that its more precise terms allow one to better discriminate between a wide range of forms often previously included in one form of an inflorescence. Its more detailed terminology allows more meaningful comparisons of inflorescences and the evolution of different taxa. The condensed presentation allows an easier insight and overview of the system than the existing two volumes of the series envisaged by Troll but, unfortunately, never completed. Detailed diagrams and illustrations are valuable aids in the discussion of often complex structures. It can only be hoped that this summary will promote the use of Troll's system which is a valuable tool in comparative morphology and taxonomy and help establish its terminology.

3. *The Flower as a Structural and functional Unit in Aspects of pollination and dispersal Biology*: The much shorter final part then places the morphology into biological perspective, mainly in reference to pollination. Various syndromes and concepts such as cross pollination, self-incompatibility, herkogamy and dichogamy are considered as well as the morphology of various flowers considered typical of wind, water and animal pollination. This is followed by fruit classification and dispersal; the fruit being considered as a flower at the stage of maturity of the seeds. Although this might seem contrary to the title of the book it enriches the usefulness of this fundamental reference book.

The extremely condensed style is similar to the widely used "Strassburger" but here the advanced student and researcher is also provided with a wide range of references.

**ASCOMYCETE SYSTEMATICS: THE LUTTRELLIAN CONCEPT**, edited by D. R. Reynolds, with pp. ix + 242 and 122 figs. ISBN 3-540-90488-3. Berlin, Heidelberg, New York: Springer-Verlag, 1981. Cloth DM 79, approx. US \$41.50.

This further contribution to the *Springer Series in Microbiology* (editor: M. P. Starr) is a report on the application of the Luttrellian concept to fungal systematics by some of the most eminent authorities in the field of ascomycetology. This book assesses the progress of Luttrell's approach ("... an emphasis on the relationship between the ascus and the totality of ascocarp components") and the utilization of this concept with regard to fungal groups where different taxonomic systems have traditionally been used.

In the first part of this volume (the ascus) the form and function of the ascus is emphasized. The ascus that produces a specialized pore in the apex through which the ascospores are discharged is analysed; the discomycetous ascus with an operculum is discussed; the basic concept of the bitunicate ascus is evaluated; and the ascus in a group of fungi similar to the discomycetous ascomycetes, the lichenized species in the order Lecanorales, is reviewed.

In the second part of the volume (the centrum) the authors take the attitude that the Luttrellian concept can be applied to ascomycete groups where the centrum character is not normally utilized. The plectomycete centrum is defined and elaborated upon; a centrum is considered as a possibility in discomycetous fungi; the centrum approach is taken in the lichenized ascomycetes placed in the order Lecanorales; and fungi with a pyrenomycete centrum are reviewed according to whether the component ascus is unitunicate within a non-lichenized or a lichenized ascocarp. Finally, the classic centrum containing the bitunicate ascus is considered by E. S. Luttrell himself.

The book is very well written and the quality of production is excellent. The line drawings and black and white photographs effectively cover the important aspects of the structure and ultrastructure of the ascocarp and ascus. References for each chapter are grouped at the end of the chapter and seem to be quite adequate. This book would be of benefit to undergraduates and postgraduates having the necessary background. It can be thoroughly recommended to practising Mycologists and research workers.

ALBERT EICKER

**A FIELD GUIDE TO THE TREES OF SOUTHERN AFRICA**, by Eve Palmer, with pp. 393, 32 colour plates and 700 line drawings. 2nd ed. 190 × 125 mm. London and Johannesburg: Collins. Hardcover R15.95.

This book, by the author of a comprehensive three volume reference work on trees of Southern Africa, is intended as a field guide to all the tree genera of Southern Africa, excluding Mozambique, and includes some 980 indigenous and some 50 naturalised species. The keys are based essentially on vegetative characteristics, namely leaves—with flowers, fruits, bark, habit and habitat data being used as unimportant extra aids to identification and for information. In addition, many of the species are illustrated with line drawings, by Rhona Collett.

The contents include some useful guidelines on how to use the book, and there is a fairly comprehensive illustrated glossary to aid those troubled by botanical nomenclature. Then follows some 37 pages of partly illustrated keys to groups (and genera).

The main bulk of the text comprises descriptions of the more common, and some rare species with keys to species in the bigger genera like *Acacia*, *Rhus*, *Maytenus*, etc. This part of the text has numerous line drawings in which the artist has made a commendable effort at capturing those important and/or diagnostic specific characters. Finally the national list of indigenous South African trees produced by the Botanical Research Institute is included for ready reference to numbered trees that the reader may find in the field. There is also a selected bibliography and separate indices to African names and a general index to English, Afrikaans and scientific names.

I feel that an important general omission from the book is the lack of distribution maps, and that the "scale line" is not always present on the sketches (especially in the key). Also, not all the nomenclature is up-to-date (e.g. *Celtis durandii* is now *C. gomphophylla* and *Olea africana* is *O. europaea* subsp. *africana*). There are some spelling mistakes (e.g. *Chaetachme* should be *Chaetacme*), and there are rather too many typographical errors such as the omission of *NOT* in the all important key to groups (page 26 *Group 8* Leaves alternate, margin entire—should be margin *not* entire) and errors on page 335.

Despite some of the shortcomings this toughly bound guide provides much useful information to the layman and botanist alike. I would certainly strongly recommend that anyone seriously interested in tree identification in southern Africa should consider this book for their library.

E. J. MOLL

THE VEGETATION OF AUSTRALIA, by Noel C. W. Beadle, with pp. xxvii + 690, 416 figures and 91 tables. ISBN 0-521-24195-2. Cambridge: Cambridge University Press, 1981. £50.00.

Prof. Noel Beadle's *Vegetation of Australia* is the first publication to attempt a modern descriptive survey of the vegetation of that vast continent. Drawing on his own work and that of others, the author has bravely attempted to sort a vast array of data into a reasonably comprehensive synthesis of Australian vegetation types. This is summed up in a vegetation map which identifies 90 major plant alliances.

Those of us in South Africa familiar with Acocks' "Veld Types" will find Beadle's monochrome map with its rather complicated symbols, a little diffuse. For example, the boundaries between vegetation alliances are not always clear, especially in Central Australia, where (presumably due to incomplete data) the situation is rather confused. But despite these reservations, when one considers the awesome size of the landmass Beadle is dealing with, one can only be lost in admiration at what he has achieved.

The initial 130 pages of this book serve as an introduction by discussing general aspects of Australian vegetation; the Australian environment, climate, soil types; the flora, its origin and evolution; while the remainder of the book is devoted to descriptive accounts of Australian plant communities. These range from rain forests through the ubiquitous *Eucalyptus* communities, to heathlands, deserts and even sea grasses and marine meadows. Naturally, pride of place goes to the *Eucalyptus* communities which account for eight chapters and nearly one-third of the whole book. Throughout this work Beadle uses the association as his basic vegetation unit—defined as a community in which the dominant stratum exhibits uniform floristic composition; the community usually exhibiting uniform structure.



The author has been very generous with his photographs. There must be at least one on every page. What is more, they are exceptionally clear and very well reproduced. Indeed, they convey most graphically the structure and texture of the communities under discussion. A high grade glossy paper is used throughout which gives the whole book a stamp of quality. It is therefore rather disappointing to see so many typographical errors, especially where binomials are used; e.g. *Disphania australe* (p. 494) and *Disphymia australe* (p. 603) are just two variations on what is correctly reported as *Disphyma australe* elsewhere.

A generous reference list and index complete the text.

This is obviously a work of great importance to Australian botanists and of considerable interest to others, especially in southern hemisphere countries where similar alliances, like heathlands for example, are also found. It will clearly remain the definitive text on Australian vegetation for some time. Producing a pioneering work is often a thankless task. This one must have been particularly difficult but in the end Prof. Beadle has given us a highly informative work which is also a pleasure to use and to read. It made me want to learn much more about Australian vegetation.

J. P. ROURKE

AUSTRALIAN VEGETATION, edited by R. H. Groves, with pp. xiv + 449, 58 figures and 33 tables. 235 × 160 mm. Cambridge: Cambridge University Press, 1981. Hardcover £27.50.

Richard Groves, of the C.S.I.R.O. Division of Plant Industry in Canberra, who has edited the eighteen chapters which comprise this book, is well known for his ecological work on heathlands and grasslands in particular. For the present volume he has obtained specialist contributions from twenty-two authors and co-authors and has done well to maintain a reasonably uniform and easy style of presentation throughout.

The contents of this book are conveniently structured into four major sections. Chapters one to three are introductory chapters which set the scene for the main body of the text, and include the phytogeographic setting for the Australian floristic kingdom, some important items on the vegetation history, and a section on alien plants. The treatment of the major vegetation types then follows with chapters on the various forest, woodland, shrubland, heathland and grassland components. There are then four chapters on the vegetation types of extreme habitats which include mangroves and salt marshes, fresh water wetlands, alpha and sub-alpine vegetation and desert communities. Finally there is a last chapter on the conservation of vegetation types followed by an author index, an index to scientific names and a subject index.

This book, which will appeal to all those seriously interested in Australian vegetation, is aimed at undergraduates and post-graduates, and has a nice balance between text and illustrative material.

Perhaps more community photographs could have been added as well as a specific chapter on coastal dune systems in the section on vegetation of extreme habitats. Also, since strip and open-cast mining has caused great concern to conservationists, and considerable research has been done on re-vegetation programmes in Australia, a special chapter on this aspect should perhaps have been included.

I would strongly recommend this book as an introductory text to the vegetation of Australia. Since we in South Africa share much in common with this southern



continent the text is relevant to local students and is certainly a must for libraries and Departments of Botany of our Universities.

E. J. MOLL

ZUR FEINSTRUKTUR, CHEMIE UND TAXONOMISCHEN SIGNIFIKANZ EPICUTICULARER WACHSE UND ÄHNLICHER SEKRETE, by Wilhelm Barthlott and Eckhard Wollenweber. Wiesbaden: Franz Steiner Verlag GmbH (Tropische und subtropische Pflanzenwelt 32, 1981). DM 24,80.

The overall appearance and lay-out of this handy, softcover booklet of 67 pp. is good although the double pagination is somewhat confusing. The contents is logically arranged into the following chapters:

1. *Introduction*—which gives a good literature survey.

2. *Material and methods*: The authors recommend amongst other things the use of relatively young, fresh plant organs or *air dried* herbarium material. Critical-Point-Drying and dehydration methods should be avoided.

3. *Micromorphology of the epicuticular secretions*: These secretions are classified into 7 types, i.e. continuous layers with (1) smooth surfaces, or (2) sculptured surfaces and predominantly crystalloid "projections" namely (3) irregular particles; (4) simple rodlets to threads; (5) simple flakes; (6) compound rodlets, threads and flakes composed of sub-units; and (7) rodlets to threads with microcrystalline surfaces.

4. *Chemistry of the waxes and related secretions*: The secretions consist of alkanes, long-chain alcohols, ketones and esters of long-chain fatty acids (true waxes). Pentacyclic triterpenes and phytosterols are more abundant than known previously, as are epicuticular flavonoids which are usually secreted by specialised glandular trichomes.

5. *Morphogenesis and relation between fine structure and the chemistry of the epicuticular secretions*: The comprehension of the structural diversity and the distribution pattern of these secretions gives the reader insight into the morphogenesis. The authors point out that the relationship between the chemistry and fine structure is still largely unknown although some trends can be recognised.

6. *Taxon specific distribution patterns*.

7. *Influence of environment and age on the fine structure of epicuticular waxes and related secretions*: The influence of the environmental factors on the micromorphology is limited. With age, the secretions may undergo an erosion and occasionally disappear completely.

8. *Ecological aspects of epicuticular secretions*: Epicuticular waxes have very different and partially very specialised functions, e.g. they act as a mechanism to control surface temperature under insolation.

9. *Taxonomic-systematic significance of epicuticular secretions*: The micromorphology and arrangement of especially the crystalloid secretions, proved to be a good taxonomic characteristic. The authors supply the taxonomists with a descriptive terminology and way to evaluate the systematic significance of these secretions.

10. *Summaries*: in English and German.

The index and bibliography are adequate. Unfortunately however, some references have been omitted, e.g. Frey-Wyssling, 1972 (mentioned on p. 8) and Hoch, 1979 (on p. 16).

The placing of the figures in the text, could have been more judicious, e.g. on pp. 7–10 no figures are being referred to, while on p. 11 figures 1–4 are inserted.

Reading the text, the attention is then drawn to figure 11 (p. 12) and thereafter to figure 37 (p. 16).

This publication should be very valuable for postgraduate students and research workers. It has a wide application for botanists in South Africa as the study of these secretions can be used as an additional taxonomic characteristic. South African material is mentioned specifically, e.g. on pp. 17 and 48.

The publication is a valuable contribution as it is the first comprehensive coverage of this topic. This review also covers original research by the authors on about 5 000 species of vascular plants. The price of about R11 is very reasonable.

I. VON TEICHMAN

**BROMELIENSTUDIEN 1. NEUE UND WENIG BEKANNTE ARTEN AUS PERU UND ANDEREN LÄNDERN**, deur Werner Rauh, met pp. 28 + 9 figure. Wiesbaden: Franz Steiner Verlag GmbH (Tropische und subtropische Pflanzenwelt 33, 1981). DM 11,20.

Hierdie publikasie is die nuutste van 'n hele aantal publikasies van die outeur oor die onderwerp. Soos uit die subtitel afgelei kan word, word in die teks nuwe en skaars taksons in die familie Bromeliaceae beskryf. In hierdie publikasie word agt nuwe taksons deur die outeur beskryf. Die betrokke taksons ressorteer onder vier genusse, naamlik *Tillandsia*, *Vriesea*, *Guzmania* en *Pitcairnia*. In eersgenoemde genus word vier nuwe spesies, in die genus *Vriesea* twee, in die genus *Pitcairnia* een nuwe spesie beskryf. In die genus *Guzmania* word 'n nuwe variëteit beskryf.

Die beskrywings behels die latynse frase gepaardgaande met die verwysing na die holotipes en die verspreiding van die takson. Geen verspreidings kaarte word egter voorsien nie. Elkeen van die beskrywings is vergesel van foto's (in sommige gevalle twee, in ander gevalle drie) waardeur die onderskeidende kenmerke van die taksons duidelik geïllustreer word. Beskrywings van die taksons word ook in Duits voorsien.

Geeneen van die taksons wat beskryf word, word in Suid-Afrika aangetref nie en daarom is die publikasie vir die deursnee Suid-Afrikaanse plantkundige van relatief min belang. Vir taksonome in die familie Bromeliaceae en spesifiek die betrokke vier genusse, is die werk egter onontbeerlik.

Die publikasie is in Q formaat op duursame glanspapier gedruk en die foto's is van besondere hoë standaard.

P. D. F. Kok

**INFLORESZENSTUDIEN AN AIZOACEAEN, MESEMBRYANTHEMACEEN UND TETRAGONIACEEN**, by Wilhelm Troll and Focko Weberling, with pp. 99 and 48 figures. ISBN 3-515-03422-6. Wiesbaden: Franz Steiner Verlag GmbH (Tropische und subtropische Pflanzenwelt 35, 1981). DM 36,20.

This unusual publication is part of a journal but can also be obtained as a book and has thus separate paginations at the top and bottom of each page. It represents a part of, and thus follows closely, the detailed discussion of families with cymose inflorescences started by Troll (1969) in *Die Infloreszenzen* vol. 2, part 1. The pro-

ent contribution which includes original research and reviews of representative cases in each family, was published in full, separately from other families to be included in that volume of Troll's series, because it had gone beyond the envisaged scope. It was primarily written for the researcher, but would serve equally well as an instructive demonstration of the uses and versatility of Troll's system of the morphology of inflorescences or its taxonomic applications.

In all three families the thyse is widely found. Each thyse may consist of few to many dichasia with one or more flowers, depending on environmental conditions, as for instance shown in *Dorotheanthus gramineus*, or on the position, i.e. the upper or lower region of the plant, as in *Carpanthea pomeridiana*. In most cases, especially in these rosette plants, the bracts are leaf-like and have previously been regarded as leaves. The apparently axillary flowers, or at least the terminal branches of *Mesembryanthemum crystallinum*, are part of foliose monochasia, which are even more pronounced in the prostrate *Aizoon canariense* and *Aptenia cordifolia*, although here somewhat modified. Even the tufted *Delasperma cooperi* has a similar sympodial growth. An understanding of the variability of the inflorescences is needed to comprehend the complex reduction series which led ultimately to the two-leaved plants of *Conophytum* or *Lithops*. Variations on the theme, as found in *Fenestraria*, *Cheiridopsis* or *Mitrophyllum* make interesting reading well illustrated with diagrams and photographs.

The inflorescences of the family Tetragoniaceae tend to show a reduction in the number of flowers on lateral part-inflorescences but an increase in the number of them. This "bottle-brush-effect" is heightened by the tendency to loose the terminal flower, showing that determinate and indeterminate inflorescences, which were usually considered a basic difference, can occur in the same genus.

This book is written for the specialist or researcher but even he must be familiar with Troll's interpretations and terminology. An introductory chapter explains many of the abbreviations used while others are presumably self-explanatory, at least when used for the first time. When a researcher is, however, interested in just a part of the book he is placed in the awkward position of having to find a definition of, for instance HP, EP, CoT and GT, in Troll (1964). The book is thus not self-contained nor is it a research paper in a strict sense, where such knowledge could be presumed.

The literature references, 45 in all, show how neglected this subject has been when one considers that about 2 000 species occur in South Africa alone. The importance of this publication is, however, diminished by the unfortunate decision of the authors to publish the contribution referring to that part of the family which is now usually recognised as Molluginaceae at a later stage. In a group of families as closely related as these it would have much increased the usefulness of the comparison.

H. R. TÖLKEN

ZUR MORPHOLOGIE UND ANATOMIE DER GATTUNG *BELONANTHUS* GRAEBN. (VALERIANACEAE), by Dorothea and Focko Weberling, with pp. 41. Wiesbaden: Franz Steiner Verlag GmbH (Tropische und subtropische Pflanzenwelt 36, 1981). DM 14,20.

The publication deals with an unusual, small South American genus of Valerianaceae which occurs in the high Andes from S. Columbia to Bolivia. The authors concentrate their investigations on two species which they studied, fixed and collected in

the field. They give detailed morphological descriptions of both the vegetative and generative regions, supplemented by well documented anatomical investigations. Floral morphology is studied in depth; gynodioecy is described for one species, and morphological differences between hermaphrodite and female flowers (smaller corollas!) are recorded. Pollen morphological descriptions and chromosome numbers are also given, although some of these data were, in part, previously published. Two other species are briefly discussed; the fifth species of *Belonanthus* is mentioned in the introduction but completely ignored in the subsequent chapters. *Belonanthus* is compared with other South American high mountain rosette forming genera of Valerianaceae, notably the closely allied genus *Phyllactis*, from which *Belonanthus* has been segregated. While differences and similarities between the two genera are pointed out in various parts of the text, it would, in the reviewer's opinion, have been desirable to more directly compare the two taxa (perhaps in tabular form?) and discuss their status in greater depth.

The volume, like all others in the series *Tropical and Subtropical Plantworld*, is lavishly produced and printed on glossy, high quality paper but, unfortunately, not enough care has gone into the preparation of the present article. Considering the relative brevity of the publication (41 pages, of which more than a third are figures), it is a bit disturbing that in "References" (19 are given) (a) one publication is not cited (Benoist, 1932), (b) four publications are cited to which no reference is made in the text, and (c) for another four citations, the year of publication does not, or only in part, correspond to that given in the text. Furthermore, no reference is made in the text to various figures, or an incorrect figure number is referred to; in some cases, individual photographs making up a figure are not labelled in accordance with the figure legend, and scales are often missing. Some figures, although of good technical quality, appear somewhat redundant.

The booklet, nevertheless, is a valuable contribution to our knowledge of one of the more unusual genera of Valerianaceae. Although of little immediate relevance to South African botany, it can be recommended to anyone interested in systematically oriented morphological and anatomical investigations.

CHRISTIAN PUFF

CELL WALLS '81. Proceedings of the Second Cell Wall Meeting held in Göttingen April 8–11, 1981, edited by D. G. Robinson and H. Quader, with pp. 297, 211 figures and 32 tables. ISBN 3–8047–0669–X. Stuttgart: Wissenschaftliche Verlagsgesellschaft MBH, 1981. Paperback DM 58.

This book is a rapid publication by the Wissenschaftliche Verlagsgesellschaft MBH, Stuttgart, in softcover, measuring 150 × 220 mm. It contains the full text of 31 of the 36 lectures which were delivered at the Göttingen meeting.

The text is divided into several sections, the number of papers per section is indicated in parentheses. Organelles and Cell Wall Synthesis (5), Glucan Structure and Synthesis (12), Microfibril Orientation and Microtubules (5), Hormones, Cell Walls and Elongation (4), and Free Themes (4).

The papers chosen for inclusion by the editors are absorbing and contain a great deal of valuable information. Aspects of cell wall structure covered in this text include examples from the higher plants, as well as the green algae. The illustrations are generally of good quality. Among the themes explored, the papers by Wessels and Sietsma, and that of Ferve, present new data on the regulation of Glucan Synthetase in cell wall growth.

A major drawback to this volume is the absence of an index. Further, the lack of uniformity of the reference citations would make follow-up literature reviews by research workers rather difficult—a few of the authors list references in full, including titles, others do not. In many instances, the references are presented in the form of continuous lists.

To sum up, *Cell Walls '81* contains a wealth of information on the ultrastructure and biochemistry of cell wall synthesis. Apart from the inconsistency of the literature citations, this text is an invaluable reference source, for researchers whose interests are centred around cell wall synthesis, differentiation, ultrastructure and biochemistry.

C. E. J. BOTHA

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Preface to the reviews of the following six books dealing with *in vitro* culture techniques:

The fourth International Plant Tissue Culture (IAPTC) Congress was held in 1978 in Calgary, Canada and the fifth recently took place (July, 1982) in Tokyo, Japan. In the four years that have elapsed books on plant protoplast, cell and tissue culture have sprouted like mungbeans. In reviewing *Plant Cell Cultures: Results and Perspectives* (edited by F. Sala, B. Parisi, R. Cella and O. Ciferri) for TIBS (Trends in Biochemical Science), M. W. Fowler of the University of Sheffield expressed the conviction that not a great deal of progress had been made between the meetings in Canada and Italy. With this journal's characteristic satire the editor of TIBS captioned the review: "The stampede from Calgary to Pavia—was it too fast?" Fact is it was; not only to Pavia, but to some other conference centres and editorial offices as well. To ascertain the real progress the reader still has to rely on the professional journals, since most conference proceedings are already two years out of date by the time they are published.

PLANT CELL CULTURES: RESULTS AND PERSPECTIVES, edited by F. Sala, B. Parisi, R. Cella and O. Ciferri, with pp. xix + 433. ISBN 0-444-80204-5. Amsterdam, New York, Oxford: Elsevier/North Holland Biochemical Press, 1980. US \$65.50.

The book represents the proceedings of an international conference held in Pavia, Italy in August 1979. The title, however, obscures the fact that in addition to cells a very large part of the contents were devoted to protoplasts, tissues, organs and plants. The book is divided into seven parts and provided with author and subject indices. The first part, "The problem, the state of the art and the perspectives" allows the authors to indulge in a little speculative biology. The term *art* tends only to underscore that much of tissue culture technology today still is empirical and comprises too much of what might be termed as hits and misses and happenings.

The organization of the remaining six parts contains elements of randomness. Under "Plant propagation through tissue culture", there are papers on riboflavin and roots, germplasm storage, and proliferation of protoplasts and cell cultures. Under "The contribution of classical genetics and of somatic cell genetics to plant improvement", one finds a consideration of growth and morphogenesis, and so forth. As a



previous reviewer has pointed out, what is lacking is an introduction by the editors to each of the sections. This would have assisted the reader in obtaining a better grasp of the perspectives, instead of leaving the impression that cleverly-contrived section headings are to be depended upon for orientation.

The quality of the papers are extremely varied and some are meaninglessly brief. The contents of a few are familiar from previous publications and the gist of others recall similar deliveries at the Calgary meeting a year earlier.

The vexing thing is that in spite of the limited number of relevant papers to any particular line of research and the high cost, this is a volume that the tissue culture worker would want in the laboratory, but it is a book for the institutional library and not for the individual. I am afraid, too, that the Pavia proceedings will remain overshadowed by those of both Calgary (1978) and Tokyo (1982).

C. H. BORNMAN

ADVANCES IN PROTOPLAST RESEARCH, edited by L. Ferecny and G. L. Farkas, with pp. ix + 511. ISBN 0-08-025528-0. Oxford, New York, Toronto, Sydney, Paris, Frankfurt: Pergamon Press Ltd., 1980.

This volume contains a selection of 59 contributions to the Vth International Protoplast Symposium, organised under the auspices of the Hungarian Academy of Sciences and held in Szeged in July 1979. The proceedings were published late in 1980, becoming generally available in 1981.

The symposium was intended to cover widely ranging aspects of bacterial, fungal and higher plant protoplast research, but the topic of greater interest was that of protoplast fusion. In fact 50 % of the papers embrace the word *fusion* in their titles.

It is easy to be critical in retrospect, but more difficult to be so as regards the proceedings of a conference, since these usually consist of a series of papers organised in sequential pattern by one or more editors. However, with the heavy emphasis on fusion, other—in some respects more important—problems were skimmed over by the Szeged symposium. One of these, as far as the higher plant is concerned, is regeneration of the entire plant from a protoplast. This, to date, has not been achieved in too many species, so that a title such as "Fusion of citrus and tobacco protoplasts—a new system for somatic hybridisation studies with remote species" becomes highly academic and just ever so slightly far-fetched.

We now know, again in retrospect, that in the intervening period (1979, 1980, 1981) there have been some advances in protoplast fusion using electrical fields, but systems for the reproducible regeneration of large numbers of plants from protoplasts are still few and far between.

In fairness, it must be stated that without exception the papers are packed with useful information, especially as regards manipulative techniques. Of the many interesting contributions I should like to single out two dealing with fusion. These are: "The physiology of fusion in isolated higher plant protoplasts as a basis for somatic cell genetics" by H. Koblitx of the GDR and "The biophysics of protoplast fusion" by D. F. Gerson *et al.* of Switzerland. The first-mentioned paper considers the problem from a biochemical viewpoint; the second uses surface physics to predict the degree of success that can be expected from cell fusion media.

Each paper has its own bibliography, but the editors have provided indices of subject, organisms and authors which make the volume eminently suitable as a ref

ence work. Other than a loss of clarity of photographs resulting from the reproduction of the authors' typescripts in their original forms, the variation in style from paper to paper does not distract. This book is an essential acquisition for those carrying out or contemplating protoplast fusion.

C. H. BORNMAN

ADVANCES IN BIOCHEMICAL ENGINEERING. PLANT CELL CULTURES I, edited by A. Fiechter, with pp. 148. ISBN 3-540-09807-0. Berlin, Heidelberg, New York: Springer-Verlag, 1980.

Volume 16 in the series *Advances in Biochemical Engineering* is on *Plant Cell Cultures*, Part I. It consists of five chapters, all except one dealing with plant cell cultures. Chapter one (G. Wilson of Dublin) compares continuous with batch culture methods of plant cell growth. The application of continuous culture methods to higher plant cells is rather new and the author describes how the design of a chemostat (or phytostat) is influenced by the morphological characteristics and growth responses peculiar to the higher plant cell (as compared with micro-organisms). Chemostat culture is shown to have the advantage over batch culture in allowing differences between effects of growth rate and those of growth-limiting substrate to identify more precisely the factors influencing cell composition and metabolism. This is a well-written chapter with theoretical and practical information on the principles and problems which apply to plant cells that are forced to behave as micro-organisms.

E. Reinhard and A. W. Alfermann (Tübingen, GFR) take up in the third chapter a subject with which they are intimately familiar, namely biotransformation by cell cultures. A large number of biotransformation patterns are reviewed, but by using cardiac glycosides as example they demonstrate that it is the particular strain of cell used that determines the pattern of biotransformation products obtained. Practical applications are also discussed.

The fourth chapter (S. J. Stohs, Nebraska, USA) describes the current knowledge regarding steroid metabolism, repeats (in less detail) Reinhard's and Alfermann's observations on cardiac glycosides, and finally purports to show that plant cell suspension cultures can effect a wide range of steroidal transformation reactions.

In the book's final contribution (S. S. Radwin and H. K. Mangold, Münster, GFR) the advantages of cell culture techniques in basic and applied lipid research are discussed. An interesting observation is that some unusual fatty acids (eg. erucic acid in *Brassica napus*) that occur in the lipids of intact plants are either present at much lower levels in heterotrophic cell cultures or not present at all.

A contribution which in one form or another has been published before, in its own right is a good mini-review of the subject, but does not belong in this volume on cells and secondary products, is that on embryogenesis in *Citrus* tissue cultures by J. Spiegel-Roy and J. Kochba (Israel). It is a pity, since it sounds a false note and effectively reduces an already expensive book from 148 to a bare 126 pages. It is with regret that I make this remark, since it concerns one of the last papers by an esteemed colleague and friend, Dr. Jehoshua Kochba. His untimely death last year robbed Israel and tissue culture of an indefatigable and good-natured worker.

C. H. BORNMAN

PLANT TISSUE CULTURE AS A SOURCE OF BIOCHEMICALS, edited by E. J. Staba, with pp. 285. ISBN 0-8493-5557-5. Boca Raton, Florida: CRC Press, 1980. US \$79.85.

When used in cell suspension cultures, there are many difficulties in getting higher plant cells to behave like single-celled bacteria and fungi: they grow slowly and tend to aggregate, produce low concentrations of products, often do not synthesize the desired substances, sometimes produce novel compounds, and frequently are unstable. E. J. Staba of the College of Pharmacy, University of Minnesota is editor of a book on secondary metabolites either produced or transformed by plant cells cultured *in vitro*, and since interest in the biotechnological application of cultured higher plant cells has greatly increased during the past decade, one is inquisitive to know what insights this publication offers.

The book, unfortunately, is composed of a rather motley assortment of 10 chapters, only five of which are more or less directly related to secondary products. Chapter 1 on laboratory culture (J. E. A. Seabrook) properly belongs in a first-year laboratory course manual; Chapters 2 and 5, respectively on nutrition and metabolism and storage of plant cell lines (D. K. Dougall of the W. Alton Jones Cell Science Center), while informative and highly relevant to tissue culture, have very little direct bearing on the book's title. Chapter 6A (M. Seibert and P. G. Kadkade) considers the effects of a much-neglected environmental factor on cultured tissues, namely that of light, but only two pages are devoted to its influence on secondary products. Chapter 6B (S. M. Martin) on the effects of temperature, aeration and pH, makes up 2% of the book. Chapter 9 (W. E. Goldstein, M. B. Ingle and L. Lasure) is on product cost analysis and is, I am sure, based not on experience with higher plants but on that with micro-organism fermentation. Seen in conjunction with the problems encountered when transferring fermentation technology to higher plant cells, the costs, without doubt, are unrealistically low.

What, then, remains of the book? Five chapters, of which three (Chapter 3 on secondary metabolism and biotransformation—E. J. Staba; Chapter 4 on selection of plant cell lines which accumulate compounds—J. M. Widholm; Chapter 10 on products—L. G. Nickell) are by researchers with extensive experience of secondary plant metabolites produced by cultures *in vitro*. The remaining two chapters (Chapter 7 on mass culture systems for plant cell suspension—S. M. Martin; Chapter 8 on industrial and government research—M. Misawa) deal with technical aspects and practical applications of mass cell culture.

Chapters 3, 4 and 10 supply interesting biochemical and physiological data on the great variety of known secondary products, including alkaloids, antitumour agents, cardiac glycosides, immunochemicals, medicinals, sweeteners, vitamins, etc. They touch on an aspect that in some cases may be even more important than the production of a secondary product, namely the biotransformation by cultured cells of one compound to another (e.g.  $\beta$ -methyl digitoxin to  $\beta$ -methyl digoxin by *Ruta graveolens*). Chapter 8 provides some insight into what is happening at the industrial level, particularly in Japan where, among other products, suspension culture techniques are being used for the production of tobacco cells as a raw material for cigarettes. It seems obvious that there must be many commercial companies with pharmaceutical interests also in Europe and in the US where practical advantage of tissue culture is being taken for industrial application, but where for commercial reasons little is disclosed about specific production processes. This book will have specialist appeal, particularly for those biochemists, natural products chemists and plant physiologists working with secondary product metabolism. Overall, however, the impression is left of a padded, hastily-edited and poorly-integrated work.

C. H. BORNH

PLANT TISSUE CULTURE. Proceedings of the Beijing (Peking) Sino-Australian Symposium on Plant Tissue Culture, with pp. 531. ISBN 0-273-08488-7. Boston, London, Melbourne: Pitman Advanced Publishing Program, 1981. US \$45.00.

This book represents in part the proceedings of a symposium held in Peking in May 1978 under the auspices of Academia Sinica and the Australian Academy of Science. Agricultural research in China is mainly focused on essential cereal and vegetable crops and this is reflected in the contributions to the symposium by the Chinese scientists. As regards cereals and vegetables, the major emphasis is on the production of haploid plants via anther culture, with a view to obtaining homozygous lines from  $F_1$  hybrids. According to an Australian scientist who attended the symposium, there were some 700 anther culture stations in China in 1978.

A limited number of volumes of the proceedings were made available by Academia Sinica after the symposium but, perhaps for reasons of distribution and publicity, Pitman Publishing Ltd. has now added a hard cover and is responsible for sales. The contents of the proceedings are organised into three sections, those dealing with anther culture, protoplast culture and somatic hybridization, and vegetative propagation. As might be expected, the translations from Chinese into English are not always smooth. However, this is a minor discomfort when compared to the advantages of being given an insight into the state of tissue culture technology in China. There are of course, for those who do not tire of overexposure, the usual contributions by the Cockings, the Gamborgs and the Melchers.

A fact that stimulated anther culture in China was the use of a potato-based medium. A crude extract is prepared by boiling potato tubers and this is used as a substitute for the macro- and micronutrient elements of the well-known and much-used Murashige & Skoog medium. With the addition of hormones and a sugar source, the potato medium improves the ratio of green to albino plantlets produced from cereal anthers. However, today many scientists are using C. C. Chu's  $N_6$  medium augmented with 2,4-D, kinetin, casein hydrolysate, yeast extract and sucrose. The  $N_6$  medium's major feature is its low concentration of  $NH_4^+$  ions.

This book can be recommended for any tissue culture laboratory. Many of its 80 papers serve as a reminder of what can be achieved in plant breeding with simple, inexpensive equipment and media, but combined, in the case of China, with manpower and enthusiasm.

C. H. BORNMAN

CLONING AGRICULTURAL PLANTS VIA IN VITRO TECHNIQUES, edited by B. V. Conger, with pp. 273. ISBN 0-8493-5797-7. Boca Raton, Florida: CRC Press, 1981. US \$72.95.

The Chemical Rubber Company Press Inc. of Boca Raton, Florida, USA has in recent years published a number of books with botanical themes, some of which, in my opinion, rate as very good and some less so. The book in question is an excellent one, despite its somewhat misleading title, lack of uniformity of approach between the five contributors, and duplication.

As far as the title is concerned, issue can be taken with two words: cloning and agriculture. *Clone* appears to have lost some of its original meaning, namely that of a population of individuals descended by mitotic division from a single ancestor.

It is currently loosely applied by molecular biologists to describe recombinant DNA procedures as well as by those tissue culturalists who believe that all plants derived via *in vitro* techniques are clonally identical. As far as *agriculture* is concerned it is probably only in the broadest sense that one could regard orchids, ferns, *Haworthia*, *Pharbitis*, the Cactaceae, and many others as agricultural plants.

The five contributing authors are each responsible for a chapter; the chapters deal with the broad spectrum of ornamentals, fruit crops, vegetable crops, agronomic crops and trees. In the Preface, the editor gives a brief motivation for the book and points out here that no attempt was made to impose uniformity in either style or approach. This quickly becomes very obvious when reading the chapters and finding duplication of principles and procedures as these relate to media, and techniques such as selection of material, surface-sterilization, explanting and subculturing. Even plants (*Citrus*, *Coffea*, *Vitis* and others) and references are duplicated. The Introduction (by the editor, B. V. Conger) gives in a nutshell the highlights of plant tissue culture and points to several potential practical applications of this tool in agriculture. Of the latter, the book deals mostly with the aspect of vegetative micropropagation.

All five chapters are informative and very well written, and most of the relevant literature up to the time of submission appears to have been included. The contribution on fruit crops by R. M. Skirvin deserves a special mention. It includes an extensive list of those fruit crops that have been grown in tissue culture, together with the explant sources, the differentiation responses observed, the media, plant growth substances and energy sources used, and the references. In addition, the media are coded to separate tables in which details of macro- and micronutrients and vitamins are given. The reference list is exhaustive and is the only one of the chapters arranged in alphabetical sequence. As regards the type of differentiation encountered, the author indicates whether this consists of callus, adventitious buds, axillary buds, embryoids, roots, as the case may be. Included is also "growth (in a normal manner)" and this I take to mean whole plant regeneration. It is interesting, then, that when one scrutinizes the more than 500 entries it appears that in only about 8 % of cases has this been achieved. Yet Skirvin, in a concluding remark, remains positive: "There appears to be no fruit crop that cannot be grown in tissue culture provided the researcher has sufficient patience and resources."

This is a book in which a wealth of valuable information is locked, from background to problems, from technology to future prospects. However, retrieving this information will require considerable cross-chapter referral. As a source of references this book is well worth the investment.

C. H. BORNMAN



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